# RCRA Facility Investigation – Remedial Investigation/ Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site Appendix A – Comprehensive Risk Assessment

## Volume 9 of 15
## Wind Blown Area Exposure Unit

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AEU | Aquatic Exposure Unit |
| AI | Adequate Intake |
| BAF | bioaccumulation factor |
| bgs | below ground surface |
| BZ | Buffer Zone |
| CAD/ROD | Corrective Action Decision/Record of Decision |
| CD | compact disc |
| CDPHE | Colorado Department of Public Health and Environment |
| CMS | Corrective Measures Study |
| COC | contaminant of concern |
| CRA | Comprehensive Risk Assessment |
| CSF | cancer slope factors |
| cy | cubic yards |
| DOE | U.S. Department of Energy |
| DQA | data quality assessment |
| DQO | data quality objective |
| DRI | dietary reference intake |
| ECOC | ecological contaminant of concern |
| ECOI | ecological contaminant of interest |
| ECOPC | ecological contaminant of potential concern |
| Eco-SSL | ecological soil screening level |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| ERA | Ecological Risk Assessment |

| | |
|---|---|
| ESL | ecological screening level |
| EU | Exposure Unit |
| FWS | U.S. Fish and Wildlife Service |
| HHRA | Human Health Risk Assessment |
| HI | Hazard Index |
| HRR | Historical Release Report |
| HQ | hazard quotient |
| IA | Industrial Area |
| IAEU | Industrial Area Exposure Unit |
| IAG | Interagency Agreement |
| IHSS | Individual Hazardous Substance Site |
| LOAEL | lowest observed adverse effect level |
| LOEC | lowest observed effects concentration |
| LWNEU | Lower Walnut Drainage Exposure Unit |
| LWOEU | Lower Woman Drainage Exposure Unit |
| MDC | maximum detected concentration |
| mg | milligram |
| mg/day | milligram per day |
| mg/kg | milligram per kilogram |
| mg/kg BW/day | milligram per kilogram receptor body weight per day |
| mrem | millirem |
| msl | mean sea level |
| N/A | not applicable or not available |
| NFAA | No Further Accelerated Action |
| NOAEL | no observed adverse effect level |

| | |
|---|---|
| NOEC | no observed effect concentration |
| OU | Operable Unit |
| PAC | Potential Area of Concern |
| PCB | polychlorinated biphenyl |
| PCOC | potential contaminant of concern |
| PMJM | Preble's meadow jumping mouse |
| PRG | preliminary remediation goal |
| QAPjP | Quality Assurance Project Plan |
| QA/QC | quality assurance/quality control |
| RCRA | Resource Conservation and Recovery Act |
| RDA | recommended daily allowance |
| RDI | recommended daily intake |
| RFCA | Rocky Flats Cleanup Agreement |
| RfD | reference doses |
| RFETS | Rocky Flats Environmental Technology Site |
| RI/FS | Remedial Investigation/Feasibility Study |
| SAP | Sampling and Analysis Plan |
| SCM | site conceptual model |
| tESL | threshold ESL |
| TRV | toxicity reference value |
| UBC | Under Building Contamination |
| UCL | upper confidence limit |
| UL | upper limit daily intake |
| UT | uncertain toxicity |
| UTL | upper tolerance limit |

| | |
|---|---|
| UWNEU | Upper Walnut Drainage Exposure Unit |
| UWOEU | Upper Woman Drainage Exposure Unit |
| VOC | volatile organic compound |
| WBEU | Wind Blown Area Exposure Unit |
| WRV | wildlife refuge visitor |
| WRW | wildlife refuge worker |

# EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 715-acre Wind Blown Area Exposure Unit (EU) (WBEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the WBEU after completion of accelerated actions at RFETS.

Results of the risk characterization for the HHRA indicate that excess lifetime chemical and radionuclide cancer risk for the wildlife refuge worker (WRW) and the wildlife refuge visitor (WRV) in the WBEU is at or below U.S. Environmental Protection Agency (EPA)-acceptable risk range (i.e., within or below a 1E-04 to 1E-06). Hazard indices (HIs) were found to be well below 1, indicating that no significant noncarcinogenic health effects are expected for the WRW or the WRV in the WBEU. Radiation doses were estimated to be less than 1 millirem (mrem), which is well below the radiation dose limit of 25 mrem. Arsenic and plutonium-239/240 were selected as COCs for surface soil/surface sediment. No COCs were selected for subsurface soil/subsurface sediment.

Risks were calculated for arsenic and plutonium-239/240 using a tiered approach. For the WRW, the estimated total excess lifetime chemical cancer risk from arsenic in surface soil/surface sediment at the WBEU is 2E-06, based on both the Tier 1 and Tier 2 exposure point concentrations (EPCs). The estimated noncarcinogenic hazard index (HI) is 0.02, based on the Tier 1 EPC, and 0.01 based on the Tier 2 EPC. The estimated total excess lifetime radionuclide cancer risk to the WRW is 2E-06 based on the Tier 1 EPC and 9E-07 based on the Tier 2 EPC.

For the WRV, estimated total excess lifetime chemical cancer risk based on the Tier 1 EPC at the WBEU is 2E-06; the risk based on the Tier 2 EPC is 1E-06. The estimated noncarcinogenic HI is 0.01 based on the Tier 1 and 0.008 based on the Tier 2 EPC. The estimated total excess lifetime radionuclide cancer risk to the WRV is 1E-06, based on the Tier 1EPC, and 6E-07 based on the Tier 2 EPC.

Although arsenic was selected as a COC and was evaluated quantitatively in the HHRA, it has not been directly associated with historical Individual Hazardous Substance Sites (IHSSs) in the WBEU, but elevated concentrations are likely due to natural variation. Background concentrations of arsenic in the surface soil/surface sediment at RFETS range from 0.27 to 9.6 milligram per kilogram (mg/kg). Therefore, under similar exposure conditions as those evaluated for the WBEU, background risks from arsenic in surface soil/surface sediment would be 70 to 80 percent of that estimated for the WBEU, or approximately 1.4E-06 to 1.5E-06.

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ecological contaminants of interest (ECOIs) that are present in the WBEU. The ECOPC identification process is described in the Comprehensive Risk Assessment (CRA) Methodology (U.S. Department of Energy [DOE] 2005a) and

additional details are provided in Appendix A, Volume 2 of the Remedial Investigation/Feasibility Study (RI/FS) Report. Chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total polychlorinated biphenyls (PCBs) were identified as ECOPCs for representative populations of non-Preble's meadow jumping mouse (PMJM) receptors in surface soil. Only small portions of PMJM habitat are currently located in the WBEU. These habitat patches are evaluated in either the Upper Walnut Drainage Exposure Unit (UWNEU) or Lower Woman Drainage Exposure Unit (LWOEU) because the patches for PMJM within the WBEU are a small subset of the larger PMJM patches in these two adjacent EUs (Figure 1.5). Therefore, no ECOPCs were identified for individual PMJM receptors in surface soil. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology. Tier 1 and Tier 2 EPCs were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. In addition, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models were completed for several ECOPCs to provide a refined estimate of potential risk.

Using Tier 1 EPCs and default exposure and risk assumptions, no observed adverse effect level (NOAEL) hazard quotients (HQs) ranged from 78 (chromium/terrestrial invertebrate) to less than 1 (chromium III/deer mouse-insectivore). NOAEL HQs also ranged from 57 (chromium/terrestrial invertebrate) to less than 1 (chromium III/deer mouse-insectivore) using Tier 2 EPCs and default exposure and risk assumptions.

For terrestrial plants, the chromium HQ was greater than 1 using the Tier 1 and Tier 2 EPCs. However, there is low confidence placed in the chromium ESL for terrestrial plants and additional no observed effect concentration (NOEC) and lowest observed effects concentration (LOEC) values were available in the literature. Using the additional NOEC ESL, HQs were greater than 1, while no HQs greater than 1 were calculated using the additional LOEC ESL. As discussed in Attachment 5, the LOEC ESL is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight. Based on the refined analysis and the low confidence in the default ESL, it is reasonable to assume that the potential for adverse effects to terrestrial plant populations from exposure to chromium are likely to be low in the WBEU.

For terrestrial invertebrates, the chromium HQ was greater than 1 using the Tier 1 and Tier 2 EPCs. However, this ESL is based on survival effects for earthworms exposed to chromium VI. There is uncertainty in the use of this ESL because chromium III is the more prevalent form of chromium found in soils. Using a LOEC based on chromium III, HQs were less than 1 using both the Tier 1 and Tier 2 EPCs. As discussed in Attachment 5, this LOEC is representative of a concentration at which there is a 30 percent reduction in earthworm growth. The low confidence placed on the ESL based on chromium VI and the lack of an HQ greater than 1 using the LOEC ESL, indicates that the potential for adverse effects to terrestrial invertebrate populations from exposure to chromium in surface soils is likely to be low in the WBEU.

Most of the ECOPC/receptor pairs for birds and mammals had lowest observed adverse effect level (LOAEL) HQs less than or equal to 1 using the default assumptions in the risk calculations. However, the following ECOPC/receptor pairs had LOAEL HQs greater than 1 using the default exposure and toxicity assumptions:

- Chromium/mourning dove (insectivore) - LOAEL HQs were greater than 1 (HQs = 5 and 3 using Tier 1 and Tier 2 EPCs, respectively) based on the default risk model. Using a median bioaccumulation factor (BAF) rather than an upper-bound BAF for the estimation of invertebrate tissue concentrations, no LOAEL HQs greater than 1 were calculated. Based on these additional risk calculations using the median BAF, the potential for adverse effects to the mourning dove (insectivore) populations in the WBEU are likely to be low.

- Nickel/deer mouse (insectivore) – LOAEL HQs were greater than 1 (HQs = 6 and 4 using Tier 1 and Tier 2 EPCs, respectively) based on the default risk model. Using a median BAF rather than an upper-bound BAF for the estimation of invertebrate tissue concentrations, no LOAEL HQs greater than 1 were calculated. In addition, HQs were also calculated using additional TRVs from the literature. No HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV in the refined analysis. Based on these refined risk calculations using the median BAF or additional TRVs, the potential for adverse effects to the mourning dove (insectivore) populations in the WBEU are likely to be low.

Based on default and refined calculations, site-related risks are likely to be low for the ecological receptors evaluated in the WBEU. In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data, and therefore, there are no ecological contaminants of concern (ECOCs) for the WBEU.

# 1.0 WIND BLOWN AREA EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Wind Blown Area Exposure Unit (EU) (WBEU) at the Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report). The anticipated future land use of RFETS is a wildlife refuge. Consequently, two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at the RFETS. The HHRA and ERA methods and selection of receptors are described in detail in the approved Final CRA Work Plan and Methodology Revision 1 (U.S. Department of Energy [DOE] 2005a) (hereafter referred to as the CRA Methodology).

## 1.1 Wind Blown Area Exposure Unit Description

This section provides a brief description of the WBEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report. This information is also summarized in Appendix A of Volume 2 of the RI/FS Report.

The Historical Release Report (HRR) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS (DOE 2005b). The original HRR (DOE 1992) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG 1991) and the 1996 Rocky Flats Cleanup Agreement (RFCA 1996), the DOE has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs also have been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report Section 1.4.3 of the RI/FS Report describes the accelerated action process, while Table 1.4 of the RI/FS Report summarizes the disposition of all historic IHSSs at RFETS. The 2005 Annual Update to the HRR (DOE 2005b) provides a description of the potential contaminant releases for each IHSS, and any interim response to the releases; identification of potential contaminants based on process knowledge and site data; data collection activities; accelerated action activities (if any); and the basis for recommending NFAA.

Several IHSSs exist within the WBEU (Table 1.1 and Figure 1.2). All the IHSSs have regulatory agency-approved NFAAs, as documented in the Annual Updates to the HRR (Table 1.1). Several of these IHSSs required accelerated action. Approximately 200 cubic yards of contaminated material were removed from Trench T-2 (IHSS 109). The excavated soil was treated by low-temperature thermal desorption and returned to the trench as "clean" backfill. Approximately 5,000 cubic yards of material were removed from Trenches T-3 (IHSS 110) and T-4 (IHSS 111.1), followed by thermal desorption processing of the material. The processed material was returned to Trench T-3 enveloped in a geotextile fabric. Approximately 420 cubic yards (cy) of contaminated material were removed from Trenches T-6 (IHSS 111.3) and T-8 (IHSS 111.5). A surface soil hot spot was removed from Trench T-7 (IHSS 111.6). At the 903 Pad (IHSS 112 ), 20,213 cy of radionuclide contaminated-soil and 4,467 cy of asphalt were removed. Another 49,800 cy of radionuclide-contaminated soil were removed from the 903 Lip Area (IHSS 155). At the East Firing Range (PAC SW-1602), 520 cy of metal-contaminated soil were removed. All other IHSSs in the WBEU were dispositioned as NFAA based on characterization results. In general, accelerated actions were designed to address human health exposures. The intent of the ecological component of the CRA is to evaluate any potential risk to ecological receptors associated with the residual contamination at the site following the accelerated actions.

### 1.1.1 Exposure Unit Characteristics and Location

The 715-acre WBEU is located in the east-central portion of RFETS (Figure 1.1) and contains several distinguishing features:

- The WBEU is located within the Buffer Zone (BZ) OU, and its western boundary is adjacent to the areas that were used historically for operation of RFETS.
- The WBEU includes a portion of the Woman Creek Drainage that is east of the Industrial Area (IA) and south of the east access road, as well as small portions of the Walnut Creek Drainage that are north of the east access road and immediately east of the IA. Runoff from other areas of the WBEU flows to the east and off site via ephemeral drainages.
- The 903 Pad and 903 Lip Area IHSSs are located in the western portion of the WBEU, where plutonium and americium were released into surface soil as a result of storing contaminated liquids in drums that leaked over time. Wind

erosion resulted in migration of this contamination to the east. These IHSSs have been remediated through accelerated actions.

The WBEU is bounded by the Lower Woman Drainage EU (LWOEU) and Upper Woman Drainage EU (UWOEU) to the south, the Industrial Area EU (IAEU) to the west, the Upper Walnut Drainage EU (UWNEU), Lower Walnut Drainage EU (LWNEU) to the northwest, and Indiana Street to the east.

### 1.1.2 Topography and Surface Water Hydrology

A recent aerial photograph of the WBEU is presented in Figure 1.3. The WBEU is an upland area between the valleys of Woman Creek and Walnut Creek. Natural surface water drainage in the WBEU is generally to the east toward Great Western Reservoir and Standley Lake. In areas along the northern and southern boundaries of the WBEU, runoff flows north into Walnut Creek or south into Woman Creek before flowing east into Great Western Reservoir or Standley Lake, respectively. Elevations in the WBEU range from 5,980 feet above mean sea level (msl) at the western boundary near the 903 Pad to 5,670 feet msl where Badger Gulch and Mower Ditch intersect Indiana Street.

Surface water features in the WBEU include Badger Gulch and Kestrel Gulch (Figures 1.2 and 1.3), which drain from the northeastern part of the WBEU into Great Western Reservoir, located approximately one third of a mile east of the site. The WBEU also includes a short segment of Woman Creek where it flows around the north end of Pond C-2. Mower Ditch, a diversion from Woman Creek, flows along the southern boundary of the WBEU, approaching it and crossing it in a few places near the southeast corner of the EU.

### 1.1.3 Flora and Fauna

The WBEU is predominantly comprised of grassland vegetation. The major components are mesic mixed grasslands and xeric grasslands (Figure 1.4). The mesic mixed grassland is distinguished at RFETS by plant species such as western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), side-oats grama (*Bouteloua curtipendula*), prairie junegrass (*Koeleria pyramidata*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*Poa pratensis*), green needlegrass (*Stipa virigula*), and little bluestem (*Andropogon scoparius*). Xeric grasslands in the WBEU are primarily xeric needle and thread grass (*Stipa comata*) prairie with some xeric tallgrass prairie. Large reclaimed areas resulting from recent remediation activities and pavement removal are found in the western portion of the EU (Figure 1.4). Small areas of wetland and riparian woodland exist along Woman Creek and hillside seeps.

Grasslands are important to wildlife, and grassland conditions on the eastern side of RFETS including WBEU are generally good. However, weeds have degraded grasslands in some areas (PTI 1997). Weed control, erosion control, and reclamation activities that are ongoing within the WBEU will continue to promote native grasslands at RFETS.

No federally listed plant species are known to occur at RFETS. However, the xeric tallgrass prairie, tall upland shrubland, riparian shrubland, and plains cottonwood riparian woodland communities are considered rare and sensitive plant communities by the Colorado Natural Heritage Program (CNHP). RFETS also supports populations of four rare plant species that are listed as rare or imperiled by the CNHP. These include: forktip three-awn (*Aristida basiramea*), mountain-loving sedge (*Carex oreocharis*), carrionflower greenbriar (*Smilax herbacea var. lasioneuron*), and dwarf wild indigo (*Amorpha nana*).

Numerous animal species have been observed at RFETS, and the more common of these are expected to be present in the WBEU. Common large-and medium-sized mammals include the mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), desert cottontail (*Sylvilagus audubonii*), and prairie dog (*Cynomys ludovicianus*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*). Eastern short-horned lizards (*Phrynosoma douglassii brevirostra*) are also found in the xeric grasslands within the EU. Common bird species include the meadowlark (*Sturnella neglecta*) and vesper sparrow (*Pooecetes gramineus*). The most common small mammal species include deer mice (*Peromyscus maniculatus*), prairie voles (*Microtus ochrogaster*), and different species of pocket mice, including the plains pocket mouse (*Perognathus flavescens*), silky pocket mouse (*Perognathus flavus*), and hispid pocket mouse (*Chaetodipus hispidus*).

RFETS supports two wildlife species listed as threatened or endangered species under the Endangered Species Act (USFWS 2005). The PMJM (*Zapus hudsonius preblei*) and the bald eagle (*Haliaeetus leucocephalus*) are listed as threatened species. The PMJM is a federally listed threatened species found at RFETS. The preferred habitat for the PMJM is the riparian corridors bordering RFETS' streams, ponds, and wetlands with an adjacent thin band of upland grasslands. PMJM habitat occurs along the lower reach of Lower Woman Creek along Mower Ditch in the southeastern portion of the WBEU and along the northwestern edge of the EU bordering the South Walnut Creek drainage (Figure 1.5). No PMJM have ever been captured within the boundaries of WBEU and because viable habitat for PMJM within this EU is a small subset of two larger PMJM patches in adjacent EUs, assessment of risk to the PMJM will be addressed in the UWNEU and the LWOEU, as appropriate (see Figure 1.6). The bald eagle occasionally forages at RFETS although no nests have been identified on site.

There are also a number of wildlife species that have been observed at RFETS that are species of concern by the State of Colorado (USFWS 2005). The plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) is listed as endangered by the State and has been observed infrequently at RFETS. The western burrowing owl (*Athene cunicularia hypugea*) is listed as threatened by the State and is a known resident or regular visitor at RFETS. The ferruginous hawk (*Buteo regalis*), American peregrine falcon (*Falco peregrinus*), and the northern leopard frog (*Rana pipiens*) are listed as species of special concern by the State and are considered known residents or regular visitors at RFETS. The following species are listed as species of special concern and are observed infrequently at RFETS: greater sandhill crane (*Grus canadensis tibida*), long-billed curlew (*Numenius americanus*), mountain plover (*Charadrius montanus*), and the common garter snake (*Thamnophis sirtalis*).

More information on the plant communities and animal species that exist within RFETS and the methodology of creating site-wide PMJM habitat patches is provided in Section 2.0 of the RI/FS Report.

### 1.1.4 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, sediment, surface water, and groundwater samples were collected from the WBEU. The data set for the CRA was prepared in accordance with data processing steps described in Appendix A, Volume 2, Attachment 2 of the RI/FS Report. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2). The sampling locations for these media are shown in Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.6. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected, or were detected in less than 5 percent of the samples, are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs), and are discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical quality assurance/quality control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a start depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report.

The CRA analytical data set for the WBEU is provided on a compact disc (CD) presented in Attachment 6. The CD includes the data used in the CRA as well as data not considered useable. Additional criteria for exclusion of data from use in the CRA are presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the WBEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and
- Subsurface soil data (ERA).

The data for these media are briefly described below.

In addition, because ECOPCs were identified for soil in this EU, surface water data were used in the ERA as part of the overall intake of ECOPCs by ecological receptor. The surface water data used in the ERA are summarized in Table 8.5. Surface water and sediment are assessed for ecological receptors on an aquatic exposure unit (AEU) basis in Appendix A, Volume 15B of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report**.**

***Surface Soil/Surface Sediment***

The combined surface soil/surface sediment data set for the WBEU consists of up to 347 samples that were analyzed for inorganics (160 samples), organics (107 samples), and radionuclides (347 samples) (Table 1.2). The data include sediment samples collected to depths down to 0.5 feet bgs. The sampling locations for surface soil and surface sediment are shown in Figure 1.6. All sample locations within the WBEU were not necessarily analyzed for all analyte groups (see Table 1.3). Surface soil/surface sediment samples were collected in the WBEU for several months from July 1991 through October 1994 and then again for several months from February 1998 through January 2005. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations in Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in surface soil/surface sediment for the WBEU is presented in Table 1.3. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups. A summary of analytes that were not detected or were detected in less than 5 percent of the surface soil/surface sediment samples in the WBEU is presented and discussed in Attachment 1.

***Subsurface Soil/Subsurface Sediment***

The combined subsurface soil/subsurface sediment data set for the WBEU consists of up to 580 samples that were analyzed for organics (580 samples), inorganics (314 samples), and radionuclides (417 samples) (Table 1.2). The data include subsurface sediment samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The sampling locations for subsurface soil and subsurface sediment are shown in Figure 1.7. All sample locations within the WBEU were not necessarily analyzed for all analyte groups (see Table 1.4). Subsurface soil/subsurface sediment samples were collected in the WBEU for several months from August 1991 through May 1995 and in May 1997. Samples were again collected for several months from February 1998 through April 2000 and from January 2002 through March 2005.

The data summary for subsurface soil/subsurface sediment in the WBEU is presented in Table 1.4. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups. A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil/subsurface sediment samples is presented and discussed in Attachment 1.

***Surface Soil***

Data meeting the CRA requirements are available for up to 335 surface soil samples collected in the WBEU that were analyzed for inorganics (151 samples), organics (98 samples), and radionuclides (335 samples) (Table 1.2). The surface soil sampling locations for the WBEU are shown in Figure 1.6. All sample locations within the WBEU were not necessarily analyzed for all analyte groups (see Table 1.5). Surface soil samples were collected in the WBEU for several months from July 1991 through October 1994 and again for several months from February 1998 through January 2005. For the grid sampling, five individual surface soil samples were collected and composited from each 30-acre cell, one from each quadrant, and one in the center, as described in the CRA SAP Addendum #04-01 (DOE 2004).

The data summary for detected analytes in WBEU surface soil is presented in Table 1.5. Radionuclides, organics, and inorganics were detected in WBEU surface soil samples. A summary of analytes that were not detected, or were detected in less than 5 percent of the surface soil samples is presented and discussed in Attachment 1.

***Subsurface Soil***

The subsurface soil data set for the WBEU consists of up to 579 samples that were analyzed for organics (579 samples), inorganics (313 samples), and radionuclides (414 samples) (Table 1.2). Subsurface soil sampling locations are shown in Figure 1.7. All sample locations within the WBEU were not necessarily analyzed for all analyte groups (see Table 1.6). Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. Subsurface soil samples were collected in the WBEU for several months from August 1991 through May 1995 and for several months from February 1998 through April 2000. Subsurface soil sampling was again performed for several months from January 2002 through March 2005.

The data summary for detected analytes in subsurface soil for the WBEU is presented in Table 1.6. Subsurface soil samples were analyzed for inorganics, organics, and radionuclides, and representatives from all three analyte groups were detected. A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples is presented and discussed in Attachment 1.

## 1.2 Data Adequacy

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2, Attachment 3 of the RI/FS Report. The adequacy of the data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. If the data do not meet the guidelines, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) are examined to determine if it is possible to make risk management decisions given the data limitations.

The findings from the data adequacy assessment applicable to all EUs are as follows:

- The radionuclide and inorganic surface soil data are adequate for the purposes of the CRA.

- For herbicides and pesticides, although the existing surface soil and sediment data may not meet the minimal data adequacy guidelines for each EU, there is considerable site-wide data, and pesticides and herbicides are infrequently detected at low concentrations, generally below PRGs and ESLs. This line of evidence indicates that it is possible to make risk management decisions without additional sampling for these analyte groups.

- For dioxins, although the existing surface soil and sediment data do not meet the minimal data adequacy guidelines for each EU, sample locations were specifically targeted for dioxin analysis at historical IHSSs in and near the former Industrial Area where dioxins may have been released based on process knowledge. Some of the dioxin concentrations at the historical IHSSs exceed the PRG and/or ESL. Additional samples were collected in targeted locations that represented low-lying or depositional areas where dioxin contamination may have migrated via runoff from these specific IHSSs. Results indicated that dioxin concentrations are not above the minimum ESL in sediment and dioxins are not detected in surface water. Therefore, although the existing data do not meet the minimal data adequacy guidelines for each EU/AEU, it is possible to make risk management decisions without additional sampling. However, unlike pesticides and herbicides where there is considerably more site-wide data, there is greater uncertainty in the overall risk estimates because fewer samples were collected at the site for dioxins.

- Subsurface soil contamination is largely confined to historical IHSSs (that is, areas of known or suspected historical releases). These areas have been characterized to understand the nature and extent of potential releases. For historical IHSSs where subsurface soil samples were not collected for an analyte group, the presence of this type of subsurface contamination was not expected based on process knowledge. Therefore, the existing subsurface soil data are adequate for the purposes of the CRA.

The findings from the data adequacy report applicable to the WBEU are as follows:

- The number of surface soil and surface soil/surface sediment samples for VOCs, SVOCs, and PCBs meet the data adequacy guideline. Furthermore, the samples are well distributed throughout the EU, and therefore, meet the data adequacy guideline for spatial representativeness.

- No surface soil or sediment samples were collected for dioxins in the WBEU. Although this does not meet the minimal data adequacy guideline, as noted above, dioxins are not expected to have been released in the WBEU and it is possible to make risk management decisions without additional sampling.

- The data adequacy guideline for number of surface water samples is met for radionuclides, metals, and VOCs, but only 4 samples for SVOCs and 2 samples for PCBs. However, SVOCs and PCBs were not detected in surface water in the WBEU. Although SVOCs and PCBs are detected in surface soil and surface sediment in the WBEU and elsewhere at RFETS, they are present at low concentrations in surface water sitewide when detected, and are often non-detected. Therefore, although the existing WBEU SVOC and PCB surface water data do not meet the minimal data adequacy guidelines, available information on surface water concentrations in the WBEU and elsewhere at RFETS indicates that SVOCs and PCBs not likely to be detected in the EU surface water, and it is possible to make risk management decisions without additional sampling.

- Surface water sampling locations are distributed along ephemeral streams in the western portion of the WBEU and along the South Interceptor Ditch. There is also a station on the ephemeral stream at the eastern boundary of the WBEU. Therefore, the sample locations meet the data adequacy guideline for spatial representativeness.

- Although current data exist for radionuclides and metals, there are no surface water data from 2001 to the present for any of the organic analyte groups. However, the pre-2001 data indicate that the organics are either less than the PRGs/ESLs or non-detected. Therefore, although the WBEU organic data do not meet the data adequacy guideline for temporal representativeness, the existing data indicate concentration trends for the constituents in these analyte groups are unlikely, and it is possible to make risk management decisions without additional sampling.

- For analytes not detected or detected in less than 5 percent of the samples in surface soil, sediment, and subsurface soil, there are several analytes that have detection limits that exceed PRGs/ESLs. However, with the exception of di-n-butylphthalate in surface soil, these analytes contribute a low level of uncertainty to the overall risk estimates because either only a small fraction of the detection limits are greater than the PRGs/ESLs, the maximum detection limits are of the same order of magnitude as the PRGs/ESLs, or professional judgment indicates they are not likely to be ECOPCs in surface soil even if detection limits had been lower. Di-n-butylphthalate has potential to be an ECOPC in the WBEU surface soil based on professional judgment, and it would present a potential for adverse ecological effects if it was detected at its maximum detection limit. Consequently, there is some uncertainty in the overall risk estimates because of the higher detection limits associated with di-n-butylphthalate, i.e., ecological risks may be underestimated because this analyte may have been included as an ECOPC had it been detected more frequently using lower detection limits (see Attachment 1 for a more detailed discussion).

## 1.3 Data Quality Assessment

A data quality assessment (DQA) of the WBEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of precision accuracy representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in this CRA and the CRA DQOs have been met.

# 2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the WBEU. Results of the COC selection process are summarized below.

## 2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

### 2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicological factors are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AIs), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

### 2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goal Screen

Table 2.2 compares MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it is not further evaluated. Arsenic, cesium-137, plutonium-239/240, and radium-228 were retained as PCOCs.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed in Table 2.2, and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

### 2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic was detected in more than 5 percent of surface soil/surface sediment samples and, therefore, was retained for further evaluation in the COC screen (Table 1.3). A detection frequency screen was not performed for cesium-137, plutonium-239/240, and radium-228 in surface soil/surface sediment because all reported values for radionuclides are considered detects.

### 2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic, cesium-137, plutonium-239/240, and radium-228 are presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic, cesium-137, plutonium-239/240, and radium-228 (both WBEU and background) are provided in Attachment 3. Arsenic, plutonium-239/240, and radium-228 were statistically greater than background at the 0.1 significance level, and are evaluated further in the professional judgment section.

### 2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, and pattern recognition. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, radium-228 in surface soil/surface sediment in the WBEU is not considered a COC because the weight of evidence supports the conclusion that radium-228 concentrations in surface soil/surface sediment in the WBEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

Arsenic and plutonium-239/240 are considered COCs in surface soil/surface sediment and are further evaluated in Sections 3.0 through 5.0.

## 2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.4) are screened in accordance with the CRA Methodology to identify COCs.

### 2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicological factors are eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology. Sulfide was the only cation/anion detected in subsurface soil/subsurface sediment. The effect of eliminating sulfide as a PCOC on the conclusions of the risk assessment is discussed in the uncertainty section (Section 6.0).

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment in the WBEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrients' MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 milligrams per day (mg/day), are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

### 2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. Radium-228 was the only PCOC with both an MDC and a UCL that exceeded the PRG. Therefore, radium-228 is retained for further evaluation as a PCOC.

PRGs are not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed in Table 2.5, and their effect on the conclusions of the risk assessment is discussed in the uncertainty section (Section 6.0).

### 2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

The detection frequency screen is not performed for radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

### 2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

Results of the background statistical comparison for radium-228 is presented in Table 2.3 and discussed in Attachment 3. Box plots for radium-228 (both WBEU and background) are provided in Attachment 3. Radium-228 concentrations were not statistically greater than background at the 0.1 significance level; therefore, it is not evaluated further.

### 2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because no PCOCs were retained following the background analysis.

## 2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. In surface soil/surface sediment, arsenic and plutonium-239/240 were selected as COCs in the WBEU and are further evaluated quantitatively. No analytes were selected as COCs in subsurface soil/subsurface sediment in the WBEU.

# 3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The site conceptual model (SCM), presented in Figure 2.1 of the CRA Methodology and is discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. Two types of receptors, the WRW and WRV were selected for quantitative evaluation based on the SCM. Exposure point concentrations (EPCs) were calculated for the COCs identified, and chemical intakes were estimated using the EPCs for the WRW and WRV receptors.

Tier 1 and Tier 2 EPCs were calculated for the two COCs, arsenic and plutonium-239/240, in surface soil/surface sediment for the WBEU. Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially weighted averaging approach. The methodology for these calculations is provided in Appendix A, Volume 2 of the RI/FS Report. Figure 3.1 shows the 30-acre grid used to calculate the Tier 2 EPCs. Table 3.1 presents the Tier 1 and Tier 2 EPCs for the WBEU.

Chemical intakes for WRW and WRV exposure pathways were quantified for arsenic and plutonium-239/240 using the exposure factors listed in Tables 3.2 through 3.5. Additional information on the estimation of chemical intake is presented in Appendix A, Volume 2 of the RI/FS Report and in the CRA Methodology.

# 4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Toxicity criteria are used in the risk calculations in Section 5.0. Tables 4.1 through 4.4 present the toxicity criteria (cancer slope factors [CSFs], reference doses [RfDs], dermal absorption factors, and dose conversion factors) for COCs at the WBEU. Toxicity criteria are presented for the oral, inhalation, and external exposure pathways. The dermal exposure pathway is not evaluated for inorganic chemicals and radionuclides (DOE 2004). Additional information on the human health toxicity assessment is presented in Appendix A, Volume 2 of the RI/FS Report and in the CRA Methodology.

# 5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity assessment is integrated in this section to characterize risk and radiation dose to the WRW and WRV receptors. Quantitative risks for cancer and noncancer effects were estimated using the toxicity factors presented in the Toxicity Assessment (Section 4.0) and pathway-specific intakes defined in the Exposure Assessment (Section 3.0). Details of the risk characterization methods are provided in the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report.

## 5.1 Wildlife Refuge Worker

This section presents the risk characterization for exposure to COCs at the WBEU. The WRW receptor was evaluated for exposure to arsenic and plutonium-239/240 in surface soil/surface sediment. The risk estimates for exposure to arsenic and plutonium-239/240 are summarized in Tables 5.1 and 5.2, respectively, while Attachment 4 contains the risk calculation tables.

### 5.1.1 Surface Soil/Surface Sediment

The WRW is evaluated for exposure to arsenic and plutonium-239/240 in surface soil/surface sediment by ingestion, inhalation, and external exposure (for radiological COCs only). The estimated excess lifetime cancer risks and noncancer hazards for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.1 and 5.5. The estimated radiation cancer risks and doses for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.2 and 5.6.

***Risk Characterization Results Based on Tier 1 Exposure Point Concentrations***

<u>Chemical Cancer Risks</u>

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC, is 2E-06 (Table 5.1). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

<u>Chemical Noncancer Hazards</u>

The noncancer hazard index (HI) for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC is 0.02 (Table 5.1). Arsenic is the sole contributor to the HI and the hazard is entirely from the ingestion exposure route.

<u>Radionuclide Cancer Risks</u>

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC, is 2E-06 (Table 5.2). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the inhalation exposure route.

<u>Radiation Dose</u>

The total radiation dose estimate for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC, is 3.4E-01 mrem (Table 5.2). Plutonium-239/240 is the sole contributor to the dose. The dose is predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

***Risk Characterization Results Based on Tier 2 Exposure Point Concentrations***

<u>Chemical Cancer Risks</u>

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 2 EPC, is 2E-06 (Table 5.1). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

<u>Chemical Noncancer Hazards</u>

The noncancer HI for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 2 EPC is 0.01 (Table 5.1). Arsenic is the sole contributor to the HI, and the hazard is entirely from the ingestion exposure route.

<u>Radionuclide Cancer Risks</u>

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 2 EPC, is 9E-07 (Table 5.2). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the inhalation exposure route.

<u>Radiation Dose</u>

The total radiation dose estimate for potential exposure by the WRW to surface soil/surface sediment is 2.2E-01 mrem, based on the Tier 2 EPC (Table 5.2). Plutonium-239/240 is the sole contributor to the dose, which comes predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

### 5.1.2 Subsurface Soil/Subsurface Sediment

No COCs were identified in subsurface soil/subsurface sediment. Therefore, it is not necessary to perform a risk characterization for subsurface soil/subsurface sediment in the WBEU.

### 5.1.3 Wildlife Refuge Worker Total Risk and Hazards

Risk estimates are summed across media to develop an estimate for the total risk to a receptor. This approach is followed only if the COCs in different media exhibit comparable health effects. For the WBEU, arsenic and plutonium-239/240 were selected as COCs for surface soil/surface sediment only. Total risk and hazards are summarized in Tables 5.5 and 5.6. The surface soil/surface sediment risk estimates for the WRW results in an estimated total chemical cancer risk of 2E-06 for both Tier 1 and Tier 2 EPCs and a total radionuclide cancer risk of 2E-06, based on a Tier 1 EPC, and 9E-07, based on a Tier 2 EPC. The non-cancer HI for the WRW is estimated to be 0.02, based on a Tier 1 EPC, and 0.01, based on a Tier 2 EPC. Because arsenic and plutonium-239/240 were selected as COCs in only one medium, cumulative risks from exposure to multimedia are not calculated for the WBEU.

## 5.2 Wildlife Refuge Visitor

This section presents the results of the risk characterization for potential exposure of the WRV receptor to arsenic and plutonium-239/240 in surface soil/surface sediment at the WBEU. Exposure to subsurface soil/subsurface sediment is not evaluated for the WRV. The risk estimates for exposure to arsenic and plutonium-239/240 are summarized in Tables 5.3 and 5.4, respectively, while Attachment 4 contains the risk calculation tables.

### 5.2.1 Surface Soil/Surface Sediment

The WRV is evaluated for exposure to arsenic and plutonium-239/240 in surface soil/surface sediment by ingestion, inhalation, and external exposure (for radiological COCs only). The estimated excess lifetime cancer risks and noncancer hazards for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.3 and 5.5. The estimated radiation cancer risks and doses for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.4 and 5.6.

***Risk Characterization Results Based on Tier 1 Exposure Point Concentrations***

<u>Chemical Cancer Risks</u>

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 2E-06 (Table 5.3). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

<u>Chemical Noncancer Hazards</u>

The noncancer HI for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 0.01 (Table 5.3). Arsenic is the sole contributor to the HI and the hazard is entirely from the ingestion exposure route.

<u>Radionuclide Cancer Risks</u>

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 1E-06 (Table 5.4). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the ingestion exposure route.

Radiation Dose

The total radiation dose estimate for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 7.2E-02 mrem for an adult and 2.2E-01 mrem for a child (Table 5.4). Plutonium-239/240 is the sole contributor to the dose. The dose is predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

### *Risk Characterization Results Based on Tier 2 Exposure Point Concentrations*

Chemical Cancer Risks

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 1E-06 (Table 5.3). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

Chemical Noncancer Hazards

The noncancer HI for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 0.008 (Table 5.3). Arsenic is the sole contributor to the HI and the hazard is entirely from the ingestion exposure route.

Radionuclide Cancer Risks

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 7E-07 (Table 5.4). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the ingestion exposure route; however, the inhalation exposure route also has a significant contribution.

Radiation Dose

The total radiation dose estimate for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 4.6E-02 mrem for an adult and 1.4E-01 mrem for a child (Table 5.4). Plutonium-239/240 is the sole contributor to the dose. The dose is predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

## 5.3 Summary

Risks to the WRW and WRV were evaluated for potential exposure to arsenic and plutonium-239/240 in surface soil/surface sediment at the WBEU. The chemical cancer risks and noncancer hazards are summarized in Table 5.5, and the radionuclide cancer risks are summarized in Table 5.6.

The results of the Tier 1 and Tier 2 risk characterizations indicate that estimated chemical and radionuclide risks for the WRW and WRV are at the low end or are below the target risk range for COCs exhibiting carcinogenic effects (i.e., 1 x $10^{-6}$ to 1x $10^{-4}$) (Tables 5.5 and 5.6). The Tier 1 and Tier 2 total HI estimates for arsenic are well below 1, indicating that no significant noncarcinogenic health effects are expected for the WRW or the WRV in the WBEU (Table 5.5).

An evaluation was performed of the radiation dose associated with exposure to plutonium-239/240 in WBEU surface soil/surface sediment. The results of the Tier 1 and Tier 2 dose assessments indicate that estimated doses are less than 1 mrem (Tables 5.2 and 5.4), which is well below the radiation dose limit of 25 mrem.

# 6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Appendix A, Volume 2 of the RI/FS Report. Uncertainties specific to the EU are described below.

## 6.1 Uncertainties Associated with the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the WBEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the WBEU were collected from 1991 through 2005. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. For most of the WBEU, this sampling density is exceeded because there are up to 324 surface soil/surface sediment samples for the entire 715-acre EU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were either not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, as examined in detail in Attachment 1.

## 6.2 Uncertainties Associated with Screening Values

The COC screening analyses used RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it was assumed that a future WRW will consume 100 milligrams (mg) of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed and to inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil/surface sediment for WRWs in the WBEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment also are expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the WBEU.

### 6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the WBEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed cations/anions and inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. Many of the listed organics have a low detection frequency and, therefore, are not expected to affect the results of the HHRA. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

## 6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Radium-228 in surface soil/surface sediment was eliminated as a COC based on professional judgment. There is no identified source or pattern of release in the WBEU, and the slightly elevated median value of radium-228 in the WBEU is most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of radium-228 are naturally occurring and not due to site activities. Uncertainty associated with the elimination of this chemical as a COC is low.

## 6.4 Uncertainties Associated with Calculation of Risk

The Tier 1 UCL for the WBEU surface soil/surface sediment arsenic data is 5.50 mg/kg, and the excess lifetime cancer risks are estimated to be 2.1E-06 for the WRW (Table 5.1) and 1.92E-06 for the WRV (Table 5.3). The background UCL for surface soil/surface sediment arsenic data is 4.03 mg/kg (Appendix A, Volume 2 of the RI/FS Report), which results in a background excess lifetime cancer risk of 1.5E-06. Risks associated with typical arsenic background levels in soils are equal to approximately 70 to 80 percent of the WBEU risk estimates. Therefore, potential risks from arsenic associated with site-related activities in the WBEU may be overestimated.

### 6.5 Uncertainties Associated with Calculation of Radiation Dose from Plutonium-239/240 in Surface Soil/Surface Sediment

Radiation dose may be over-estimated or under-estimated based on the radiation dose assessment methodology. Uncertainties associated with the soil/sediment concentrations, exposure scenarios, exposure pathways, exposure factors, and dose conversion factors exist. All factors are conservatively estimated so that radiation dose would tend toward being over-estimated.

### 6.6 Uncertainties Evaluation Summary

Evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the WBEU risk characterization.

## 7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ECOPC identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the WBEU. ECOIs are defined as any chemical detected in the WBEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15B of the RI/FS Report. The ECOPC process is described in the CRA Methodology (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. A detailed discussion of the ecological SCM, including the receptors of concern, exposure pathways, and endpoints used in the ERA for the WBEU, is also provided in Appendix A, Volume 2 of the RI/FS Report.

The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. The most significant exposure pathways for ecological receptors at the WBEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media. For terrestrial plants and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soils.

The receptors of concern that were selected for assessment are listed in Table 7.1 and include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within the WBEU, their potential to have contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC identification process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517). The assessment of risk to the PMJM is addressed in the adjacent UWNEU and LWOEU because the patches for PMJM within the WBEU are a small subset of the larger PMJM patches in these two adjacent EUs (Figure 1.5).

## 7.1 Data Used in the Ecological Risk Assessment

The following WBEU data are used in the CRA:

- A total of 335 surface soil samples were collected in the WBEU and analyzed for inorganics (151 samples) and organics (98 samples) and radionuclides (335 samples) (Table 1.2).

- A total of 579 subsurface soil samples were collected and analyzed for inorganics (313 samples) and organics (579 samples) and radionuclides (414 samples) (Table 1.2).

A data summary is provided in Table 1.5 for surface soil and Table 1.6 for subsurface soil.

Sediment and surface water data for the WBEU were also collected (Section 1.1.4) and are evaluated for the ERA in Appendix A, Volume 15B of the RI/FS Report. As discussed in Section 8.0, surface water EPCs are used in the risk model to estimate exposure via the surface water ingestion pathway. One hundred and thirty-six distinct surface water samples were collected in the WBEU and analyzed for inorganics (38 samples), organics (16 samples), and radionuclides (136 samples).

## 7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM receptors in accordance with the sequence presented in the CRA Methodology.

### 7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

***Non-PMJM Receptors***

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are summarized in Table 7.2. Analytes with a “Yes” in any of the “Exceedance” columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity (UT) in Section 10.0 along with the potential impacts to the risk assessment.

***PMJM Receptors***

No screening was conducted for PMJM receptors in the WBEU.

### 7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. Di-n-butylphthalate was the only ECOI detected in surface soil at the WBEU that was retained after the NOAEL ESL screening step and which had a detection frequency less than 5 percent.

Di-n-butylphthalate was detected in one of 85 surface soil samples in the WBEU. Figure 7.1 shows the sampling locations and detections. However, because 100 percent of the detection limits for this compound exceed the lowest ESL, this contributes some uncertainty to the overall risk estimates because professional judgment indicates it may be present in WBEU surface soil i.e., ecological risks may be underestimated because this analyte may have been included as an ECOPC had it been detected more frequently using lower detection limits (see Attachment 1 for a more detailed discussion).

### 7.2.3 Surface Soil Background Comparisons

ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparison is presented in Table 7.3 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

***Non-PMJM Receptors***

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.3. The analytes listed as being retained as ECOIs in Table 7.3 are evaluated further using upper-bound EPCs in the following section.

***PMJM Receptors***

No screening was conducted for PMJM receptors in the WBEU.

### 7.2.4 Exposure Point Concentration Comparisons to Threshold Ecological Screening Levels

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors are then compared to threshold ESLs (tESLs) using EPCs specific to small and large home-range receptors. The calculation of EPCs is described in Attachment 3 and Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.4. The EPC for small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]), or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL of the mean, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The upper-bound EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.5. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.6, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.7.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk assessment.

### 7.2.5 Surface Soil Professional Judgment Evaluation

***Non-PMJM Receptors***

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, barium, boron, lithium, and molybdenum in surface soil at the WBEU were not considered ECOPCs for non-PMJM receptors and, therefore, are not further evaluated quantitatively.

Chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total PCBs were identified as ECOPCs and retained for further evaluation in the risk characterization.

***PMJM Receptors***

No screening was conducted for PMJM receptors in the WBEU.

### 7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC identification process for surface soil is summarized below.

***Non-PMJM Receptors***

Most inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the WBEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in WBEU surface soils was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. Chemicals that were retained are identified as ECOPCs and are presented in Table 7.8.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.8. Receptors of potential concern for each ECOPC are also presented. The ECOPC/receptor pairs are evaluated further in Section 8.0 (Ecological Exposure Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

***PMJM Receptors***

An ECOPC identification process was not performed for PMJM in the WBEU because PMJM habitat within the WBEU was evaluated as a part of either UWNEU or LWOEU.

## 7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern

Subsurface soil sampling locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the WBEU are identified in Figure 1.7. A data summary is presented in Table 1.6 for subsurface soil less than 8 feet deep.

### 7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil is evaluated for those ECOIs that have greater concentrations in subsurface soil than in surface soil. As a conservative screening step, subsurface soil is evaluated for all EUs regardless of the presence/absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.9). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as “N/A” in Table 7.9. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10.0).

### 7.3.2 Subsurface Soil Detection Frequency Evaluation

The ECOPC identification process for burrowing receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is not further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.6. None of the chemicals in subsurface soil at the WBEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on low detection frequencies for subsurface soil in the WBEU.

### 7.3.3 Subsurface Soil Background Comparison

The ECOIs retained after the ESL screening and detection frequency evaluation were compared to site-specific background concentrations where available. The background comparisons are presented in Table 7.10 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Attachment 3.

Analyses were conducted to assess whether ECOPC concentrations in WBEU subsurface soil are statistically greater than those in sitewide background surface soil at the 0.1 level of significance. The results of the statistical comparisons of the WBEU data to background data indicate that site concentrations of antimony in WBEU subsurface soil are statistically greater than background concentrations. Antimony is evaluated further using upper-bound EPCs in the following section.

### 7.3.4 Exposure Point Concentration Comparisons to Threshold Ecological Screening Levels

ECOIs retained after all previous evaluations for burrowing receptors are compared to tESLs using EPCs specific to small home-range receptors. The calculation of EPCs is described in the CRA Methodology (DOE 2005a).

Because only antimony was retained following the background analysis step, statistical concentrations for antimony are presented in Table 7.11. The EPC comparison to tESLs for burrowing receptors is presented in Table 7.12. The subsurface soil UTL for antimony is lower than the tESL for the prairie dog receptor; therefore, antimony was not evaluated further.

### 7.3.5 Subsurface Soil Professional Judgment

ECOIs with subsurface soil concentrations that exceed NOAEL ESLs, which have been detected in more than 5 percent of samples, that have concentrations statistically higher than background data, and which exceed tESLs are subject to a professional judgment evaluation. However, no ECOIs had subsurface soil concentrations that exceeded tESLs; therefore, no weight-of-evidence professional judgment evaluation was needed for subsurface soil in the WBEU.

### 7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the WBEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in WBEU subsurface soils was not statistically greater than those in background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.13.

## 7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the WBEU were evaluated in the ECOPC identification process for non-PMJM receptors and burrowing receptors. Chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total PCBs were identified as ECOPCs for selected non-PMJM receptors (Table 7.8). No chemicals were identified as ECOPCs for the burrowing receptor (Table 7.13). No other ECOIs were retained past the professional judgment step of the ECOPC identification process for any other receptor group (non-PMJM receptors or burrowing receptors).

# 8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification process defined the steps necessary to identify those chemicals that could not reliably be removed from further consideration in the ERA process. The list of ECOPC/receptor pairs of potential concern (Table 8.1) represents those media, chemicals, and receptors in the WBEU that require further assessment. The characterization of risk defines a range of potential exposures to site receptors from the ECOPCs and a parallel evaluation of the potential toxicity of each of the ECOPCs as well as the uncertainties associated with the risk characterization. This section provides the estimation of potential exposure to surface soil ECOPCs for the receptors identified in Section 7.0 and Table 8.1. Exposure to ECOPCs via the ingestion of surface water is also considered a potentially significant exposure route as presented in the CRA Methodology (DOE 2005a). Details of the two exposure models, concentration-based exposure and dosage-based exposure, are presented in Appendix A, Volume 2 of the RI/FS Report.

## 8.1 Exposure Point Concentrations

Surface soil EPCs for all non-PMJM receptors were calculated using both Tier 1 and Tier 2 methods as described in the CRA Methodology (DOE 2005a). Tier1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set, and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. The 30-acre grid used for the Tier 2 calculations is shown in Figure 8.1. The Tier 1 and Tier 2 UTLs and UCLs are presented in Table 8.2. The methodology for the calculation of Tier 2 statistics is provided in Appendix A, Volume 2 of the RI/FS Report.

The surface water EPCs were calculated for ECOIs that were identified as soil ECOPCs using the same statistical basis as determined for the soil ECOPCs. For example, if the soil EPC statistic was the UCL, then the UCL concentration in surface water (total values only) was calculated as described for soils and selected as the EPC. Surface water EPCs for all ECOPCs are presented in Table 8.3. All surface water data are provided on CD in Attachment 6.

## 8.2 Receptor-Specific Exposure Parameters

Receptor-specific exposure factors are needed to estimate exposure to ECOPCs for each representative species. These include body weight; food, water, and media ingestion rates; and diet composition and respective proportion of each dietary component. Daily rates for intake of forage, prey, water, and incidental ingestion of soils were developed in the CRA Methodology (DOE 2005a) and are presented in Table 8.4 for the receptors of potential concern carried forward in the ERA for the WBEU.

## 8.3 Bioaccumulation Factors

The measurement or estimation of concentrations of ECOPCs in wildlife food is necessary to evaluate how much of a receptor's exposure is via food versus direct uptake of contaminated media. Conservative bioaccumulation factors (BAFs) were identified in the CRA Methodology (DOE 2005a). These BAFs are either simple ratios between chemical concentrations in biota and soil or are based on quantitative relationships such as linear, logarithmic, or exponential equations. The values reported in the CRA Methodology are used as the BAFs for purposes of risk estimation.

## 8.4 Intake and Exposure Estimates

Intake and exposure estimates were completed for each ECOPC/receptor pair identified in Table 8.1. The estimates use the default exposure parameters and BAFs presented in Appendix B of the CRA Methodology (DOE 2005a) and described in the previous subsection. These intake calculations represent conservative estimates of food tissue concentrations calculated from the range of upper-bound EPCs including the Tier 1 and Tier 2 UTLs and UCLs.

### *Non-PMJM Receptors*

The intake and exposure estimates for ECOPC/non-PMJM receptor pairs are presented in Attachment 4. A summary of the exposure estimates is presented in Table 8.5.

- Chromium – Default exposure estimates for American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore);
- Manganese – Default exposure estimates for the deer mouse (herbivore);
- Nickel – Default exposure estimates for mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore);

- Tin – Default exposure estimates for American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore);
- Bis(2-ethylhexyl)phthalate – Default exposure estimates for the mourning dove (insectivore);
- Endrin – Default exposure estimates for the American kestrel and mourning dove (insectivore); and
- Total PCBs – Default exposure estimates for the American kestrel and mourning dove (insectivore).
- Alternative exposure estimates for the mourning dove (insectivore) and deer mouse (insectivore) are provided for chromium and nickel, respectively.

## 9.0 ECOLOGICAL TOXICITY ASSESSMENT

Exposure to wildlife receptors was estimated for representative species of functional groups based on taxonomy and feeding behavior in Section 8.0 in the form of a daily rate of intake for each ECOPC/receptor pair. To estimate risk, soil concentrations (plants and invertebrate exposure) and calculated intakes (birds and mammals) must then be compared to the toxicological properties of each ECOPC. The laboratory-based toxicity benchmarks are termed toxicity reference values (TRVs) and are of several basic types. The NOAEL and no observed effect concentration (NOEC) TRVs are intake rates or soil concentrations below which no ecologically significant effects are expected. The NOAEL and NOEC TRVs were used to calculate the NOAEL ESLs employed in screening steps of the ECOPC identification process to eliminate chemicals that have no potential to cause risk to the representative receptors. The lowest observed adverse effects level (LOAEL) TRV is a concentration above which the potential for some ecologically significant adverse effect could be elevated. The threshold TRVs represent the hypothetical dose at which the response for a group of exposed organisms may first begin to be significantly greater than the response for unexposed receptors and is calculated as the geometric mean of the NOAEL and LOAEL. Threshold TRVs were calculated based on specific data quality rules for use in the ECOPC identification process for a small subset of ECOIs in the CRA Methodology (DOE 2005a).

TRVs for ECOPCs identified for WBEU were obtained from the CRA Methodology. The pertinent TRVs for the WBEU are presented for terrestrial plants and invertebrates in Table 9.1 and for birds and mammals in Table 9.2.

## 10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology (DOE 2005a) and Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and in the potential for effects on the population of receptors that could inhabit the WBEU.

Potential risks to terrestrial plants, invertebrates, birds, and mammals are evaluated using a hazard quotient (HQ) approach. An HQ is the ratio of the estimated exposure of a receptor to a TRV that is associated with a known level of toxicity, either a no effect level (NOAEL or NOEC) or an effect level (LOAEL or lowest effects concentration [LOEC]):

$$HQ = Exposure / TRV$$

As described in Section 8.0, the units used for exposure and TRV depend upon the type of receptor evaluated. For plants and invertebrates, exposures and TRVs are expressed as concentrations (mg/kg soil). For birds and mammals, exposures and TRVs are expressed as ingested doses (mg/kg BW/day).

In general, if the NOAEL-based HQ is less than 1, then no adverse effects are predicted. If the LOAEL-based HQ is less than 1 but the NOAEL-based HQ is above 1, then some adverse effects are possible, although it is expected that the magnitude and frequency of the effects will usually be low (assuming the magnitude and severity of the response at the LOAEL are not large and the endpoint of the LOAEL accurately reflects the assessment endpoints for that receptor). If the LOAEL-based HQ is greater than or equal to 1, the risk of an adverse effect is of potential concern, with the probability and/or severity of effect tending to increase as the value of the HQ increases.

When interpreting HQ results for non-PMJM ecological receptors, it is important to remember that the assessment endpoint to non-PMJM receptors is based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable. For threatened and endangered species, such as the PMJM, the interpretation of HQ results is based on potential risks to individuals rather than populations.

HQs were calculated for each ECOPC/receptor pair based on the exposures estimated and TRVs presented in the preceding sections. The NOAEL and NOEC TRVs along with default screening-level exposure assumptions are first used to calculate HQs. However, these no effects HQs are typically considered as screening level results and do not necessarily represent realistic risks for the site. EPA risk assessment guidance (EPA 1997) recommends a tiered approach to evaluation, and following the first tier of evaluation “the risk assessor should review the assumptions used (e.g., 100 percent bioavailability) against values reported in the literature (e.g., only up to 60 percent for a particular contaminant), and consider how the HQs would change if more realistic conservative assumptions were used instead.” Accordingly, LOAEL and threshold TRVs are also used in this evaluation to calculate HQs. Where LOAEL HQs greater than 1 are calculated using default exposure assumptions, and the uncertainty analysis indicates that alternative BAFs and/or TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are calculated.

### 10.1 Chemical Risk Characterization

Chemical risk characterization uses quantitative methods to evaluate potential risks to ecological receptors. In this risk assessment, the quantitative method used to characterize chemical risk is the HQ approach. As noted above, HQs are usually interpreted as follows:

| HQ Values | | Interpretation of HQ Results |
|---|---|---|
| **NOAEL-based** | **LOAEL-based** | |
| ≤ 1 | ≤ 1 | Minimal or no risk |
| > 1 | ≤ 1 | Low-level risk[a] |
| > 1 | > 1 | Potential adverse effects |

[a] Assuming magnitude and severity of response at LOAEL are relatively small and based on endpoints appropriate for the assessment endpoint of the receptor considered.

One potential limitation of the HQ approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on three potential sources of uncertainty, described below.

- **EPCs.** Because surface soil sampling programs in the EU sometimes tended to focus on areas of potential contamination (IHSS/PAC/UBCs), EPCs calculated using the Tier 1 approach (which assumes that all samples are randomly spread across the EU and are weighted equally) may tend to yield an EPC that is biased high. For this reason, a Tier 2 area-weighting approach was used to derive additional EPCs that help compensate for this potential bias. HQs were always calculated based on both Tier 1 and Tier 2 EPCs for non-PMJM receptors.

- **BAFs.** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. To estimate more typical tissue concentrations, where necessary, an alternative exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (EPA 2005).

- **TRVs.** The CRA Methodology used an established hierarchy to identify the most appropriate default TRVs for use in the ECOPC selection process. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed on a chemical-by-chemical basis in the following subsections. When an alternative TRV is identified, the chemical-specific subsections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs were evaluated both alone and in concert in the risk description for each chemical. Uncertainties related to the BAFs, TRVs, and background risk are presented for each chemical in Attachment 5. Where uncertainties were deemed to be high, Attachment 5 provides alternative BAFs and/or TRVs that are then incorporated into the risk characterization as appropriate.

HQs calculated using the default BAFs and with the Tier 1 and Tier 2 EPCs are provided in Table 10.1 for each ECOPC/receptor pair. Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology. Where no LOAEL HQs exceed 1 using the default exposure and toxicity values, no further HQs were calculated. Since the default HQs are generally the most conservative risk estimations, if low risk is estimated using these values then further reductions of conservatism would only serve to reduce risk estimates further.

Where LOAEL HQs greater than 1 are calculated using default assumptions, and the uncertainty analysis indicates that median BAFs and/or additional TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are calculated and presented in Table 10.1 as appropriate.

The selection of which EPC (e.g., UTL or UCL) is of primary importance will depend upon the type of receptor and the relative home-range size. Only the UTL EPC is provided for small home-range receptors and only the UCL is provided for large home-range receptors.

All calculated exposure estimates and HQ values are also provided in Attachment 4. These include the default and refined HQs if needed. The results for each ECOPC are discussed in more detail below.

The risk description incorporates results of the risk estimates along with the uncertainties associated with the risk estimations and other lines of evidence to evaluate potential chemical effects on ecological receptors in the WBEU following accelerated actions at RFETS. Information considered in the risk description includes receptor groups potentially affected, type of TRV exceeded (e.g., NOAEL versus LOAEL), relation of EU concentrations to other criteria such as EPA Eco-SSLs, and risk above background conditions. In addition, other site-specific and regional factors are considered such as the use of a given ECOPC within the EU related to historical RFETS activities, comparison of ECOPC concentrations within the WBEU to the rest of the RFETS site as it relates to background, and/or comparison to regional background concentrations.

### 10.1.1 Chromium

Chromium HQs for the terrestrial plants, terrestrial invertebrates, American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) are presented in Table 10.1. Figure 10.1 shows the spatial distribution of chromium in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

For terrestrial plants and invertebrates, the NOEC HQ was greater than 1 and no LOEC HQs were available using the default TRVs. For non-PMJM mammalian and avian receptors, only the mourning dove (insectivore) receptor had LOAEL HQs greater than 1, indicating a potential for adverse effects. The uncertainty analysis presented in Attachment 5 indicates that there are low confidence in the chromium risk calculations for plants and invertebrates as well as the risk calculations using the upper-bound BAFs and default TRVs in the mourning dove (insectivore) calculations. Therefore, a refined analysis was provided for plants and invertebrates using alternative NOEC and LOEC ESLs and for the mourning dove (insectivore) using a median soil-to-invertebrate BAF. The resulting HQs are presented in Table 10.1.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

#### *Chromium Risk Description*

Chromium was identified as an ECOPC for terrestrial plants, terrestrial invertebrates, American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) receptors. Refined HQs were calculated for the terrestrial plant, terrestrial invertebrate, and mourning dove (insectivore) receptors using additional TRVs for plants and invertebrates and a median soil-to-invertebrate BAF for the mourning dove (insectivore). Information on the historical use and a summary of site data and background data are provided in Attachment 3.

#### *Terrestrial Plants and Invertebrates*

For terrestrial plants, HQs were greater than 1 using the default NOEC ESL indicating a potential for adverse effects. Because no default LOEC value was available for plants, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

The uncertainty assessment in Attachment 5 discussed the low confidence placed in the chromium ESL for terrestrial plants and provided additional NOEC and LOEC values. The NOEC ESL used in the refined analysis resulted in HQs greater than or equal to 1, while no HQs greater than 1 were calculated using the LOEC ESL. As discussed in the uncertainty analysis, the alternative LOEC ESL is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight (see Attachment 5).

In addition, the default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using the UTL background concentration (HQ = 17).

The low confidence placed in the default ESL and the lack of HQs greater than 1 using the LOEC ESL in the refined analysis suggest that the potential for adverse effects to terrestrial plant populations is likely to be low.

For terrestrial invertebrates, HQs greater than 1 were calculated using the default ESL, indicating the potential for adverse effects for invertebrates. Because no default LOEC value was available, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

The uncertainty assessment in Attachment 5 discussed the low confidence placed in the chromium ESL for terrestrial invertebrates and provided an additional LOEC value. The No HQs greater than 1 were calculated using the LOEC ESL in the refined analysis. As discussed in the uncertainty analysis, the alternative LOEC ESL is representative of a concentration at which there is a 30 percent reduction in earthworm growth (see Attachment 5). In addition, the default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL background concentration (HQ = 42).

Based on the low confidence placed in the default ESL and the lack of HQs greater than 1 using the LOEC ESL in the refined analysis, the potential for adverse effects to terrestrial invertebrate populations is likely to be low.

***Non-PMJM Receptors – Small Home Range***

NOAEL HQs using default risk models were greater than 1 for the American kestrel, mourning dove (insectivore), and deer mouse (insectivore) (chromium VI TRV only). NOAEL HQs were less than or equal to 1 for the mourning dove (herbivore). All LOAEL HQs were less than 1 for all receptors except the mourning dove (insectivore). Therefore, the potential for adverse effects to populations of the American kestrel, mourning dove (herbivore), and deer mouse (insectivore) from exposure to chromium are likely to be low. Risks to the mourning dove (insectivore) using the default risk model may potentially be significant and require further evaluation.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL, threshold, and LOAEL TRVs were used in the HQ calculations. Chromium samples were available from 37 grid cells (Figure 10.1). NOAEL and LOAEL HQs greater than 1 were calculated in 100 percent of the grid cells, while no LOAEL HQs greater than 5 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low to moderate risk from exposure to chromium.

The uncertainty analysis indicated that exposure to the mourning dove (insectivore) was likely to be overestimated based on the use of upper-bound BAFs. Table 10.1 presents

HQs calculated using the identical risk model with associated default TRVs but with a median BAF rather than the conservative 90th percentile BAF. Using the median BAF, the mourning dove (insectivore) had NOAEL HQs greater than 1 using the Tier 1 EPC (HQ = 3) and the Tier 2 EPC (HQ = 2). However, LOAEL HQs were less than 1 using both EPCs. In addition, background risk calculations also indicate similar HQs for the mourning dove (insectivore) using the default HQ calculations. Based on these additional risk calculations, the potential for adverse effects to populations of mourning dove (insectivore) are likely to be low.

### 10.1.2 Manganese

Manganese HQs for the deer mouse (herbivore) receptors are presented in Table 10.1. Figure 10.2 shows the spatial distribution of manganese in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

***Manganese Risk Description***

Manganese was identified as an ECOPC for the deer mouse (herbivore) receptor only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Non-PMJM Receptors – Small Home Range***

For the deer mouse (herbivore), NOAEL HQs were equal to 1 using the Tier 1 and 2 EPCs. LOAEL HQs were less than 1 using both EPCs. Because no HQs greater than 1 were calculated using any effects-based TRV, the potential for adverse effects to populations of the deer mouse (herbivore) are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Manganese samples were available from 37 grid cells (Figure 10.2). NOAEL HQs greater than 1 were calculated in only 8 percent of grid cells for the most sensitive receptor (deer mouse [herbivore]). No LOAEL HQs greater than 1 were calculated in any grid cell. The results of the grid-cell analysis indicate that the average exposure to sub-populations of deer mouse (herbivore) results in low risk from exposure to manganese.

### 10.1.3 Nickel

Nickel HQs for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore) are presented in Table 10.1. Figure 10.3 shows the spatial distribution of nickel in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs.

For non-PMJM receptors, only the deer mouse (insectivore) receptor had LOAEL HQs greater than 1 indicating a potential for adverse effects. The uncertainty analysis presented in Attachment 5 indicates that there were considerable uncertainties associated with both the upper-bound BAFs and the default TRVs used in the deer mouse (insectivore) risk calculations. Therefore, refined risk calculations were provided for the deer mouse (insectivore) using a median soil-to-invertebrate BAF and additional TRVs. The resulting HQs are presented in Table 10.1.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

***Nickel – Risk Description***

Nickel was identified as an ECOPC for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore) receptors. A second tier of HQs were calculated for the deer mouse (insectivore) using a median soil-to-invertebrate BAF and additional TRVs. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Non-PMJM Receptors – Small Home Range***

NOAEL HQs using default risk models were greater than 1 for the mourning dove (insectivore) and deer mouse (insectivore). NOAEL HQs were equal to 1 for the deer mouse (herbivore). LOAEL HQs were less than or equal to 1 for all receptors except the deer mouse (insectivore). Therefore, risks to populations of the mourning dove (insectivore) and deer mouse (herbivore) are likely to be low. Risks to the deer mouse (insectivore) using the default HQ calculations may potentially be significant and require further evaluation.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Nickel samples were available from 37 grid cells (Figure 10.3). NOAEL HQs greater than 10 were calculated in 100 percent of the grid cells. LOAEL HQs greater than 1 but less than 5 were also calculated in 97 percent of grid cells for the most sensitive receptor (deer mouse [insectivore]) and between 5 and 10 in 3 percent of grid cells. The results of the grid-cell analysis indicate that risks from average exposure to sub-populations of insectivorous small mammals results in low to moderate risk from exposure to nickel.

The uncertainty analysis in Attachment 5 discussed the potential for risks to at UCL and UTL background soil concentrations. For the deer mouse (insectivore), LOAEL HQs in background (UTL and UCL HQs = 3) are similar to those calculated for WBEU surface soils. These results indicate that risks to insectivorous deer mouse populations within WBEU are similar to those offsite.

The uncertainty analysis indicated that exposure to the deer mouse (insectivore) may be overestimated based on the use of upper-bound BAFs used in the default risk model. Alternative intake rates were calculated for those receptors ingesting invertebrates in their diet. In addition, HQs were also calculated using additional TRVs from Sample et al. (1996). Table 10.1 presents HQs using the default risk model but with a median BAF for invertebrates rather than the conservative 90th percentile BAF. Using the median BAF in the risk model, the deer mouse (insectivore) had NOAEL HQs greater than 1 using the Tier 1 EPC (HQ = 14) and the Tier 2 EPC (HQ =10). However, LOAEL HQs were less than or equal to 1 using both EPCs. When the additional TRVs from Sample et al. (1996) were used instead of the default TRVs, no HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV. Based on the uncertainty analysis and the refined risk calculations, the potential for adverse effects to populations of the deer mouse (insectivore) are likely to be low.

***Non-PMJM Receptors – Large Home Range***

NOAEL HQs using the default risk model were greater than 1 for the coyote (generalist and insectivore). LOAEL HQs for both receptors were less than or equal to 1 for all exposure scenarios. Because risks are classified as low using the more conservative default HQ calculations, no additional HQs were calculated for the coyote. Therefore, the potential for adverse effects to populations of large home-range receptors such as the coyote are likely to be low.

#### 10.1.4 Silver

Silver HQs for terrestrial plants are presented in Table 10.1. Figure 10.4 shows the spatial distribution of silver in relation to the terrestrial plant ESL, and also presents the data used in the calculation of Tier 2 EPCs.

The terrestrial plant receptors had LOEC HQs less than or equal to 1 but the ESL is based on unspecified effects. Therefore, it is unclear whether there is a potential for adverse effects using only the default ESL. The uncertainty analysis did not identify any alternative ESLs that could be used in a refined analysis; therefore, no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results for all receptors regardless of whether refined HQs were calculated to address uncertainties.

***Silver – Risk Description***

Silver was identified as an ECOPC for terrestrial plants only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Terrestrial Plants***

NOEC HQs were equal to 1 using Tier 1 UTL, but were less than 1 using the Tier 2 UTL. The low HQs combined with the uncertain nature and low confidence of the ESL as discussed in the uncertainty analysis (Attachment 5), coupled with the lack of known releases of silver, indicate that the potential for adverse effects to populations of terrestrial plants is likely to be low.

### 10.1.5 Thallium

Thallium HQs for terrestrial plants are presented in Table 10.1. Figure 10.5 shows the spatial distribution of thallium in relation to the terrestrial plant ESL, and also presents the data used in the calculation of Tier 2 EPCs.

The terrestrial plant receptors had LOEC HQs equal to 1 using both the Tier 1 and Tier 2 EPCs. However, the default ESL is based on unspecified toxic effects resulting in low confidence in the value. It is unclear whether there is a potential for adverse effects based on this default ESL. The uncertainty analysis did not identify any additional ESLs; therefore, no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results for all receptors regardless of whether refined HQs were calculated to address uncertainties.

***Thallium – Risk Description***

Thallium was identified as an ECOPC for terrestrial plants only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Terrestrial Plants***

NOEC HQs were equal to 1 using both the Tier 1 and Tier 2 EPCs. The low HQs combined with the uncertain nature and low confidence of the ESL as discussed in the uncertainty analysis (Attachment 5), coupled with the lack of known releases of thallium, indicate that the potential for adverse effects to populations of terrestrial plants is likely to be low.

### 10.1.6 Tin

Tin HQs for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) are presented in Table 10.1. Figure 10.6 shows the spatial distribution of tin in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

***Tin – Risk Description***

Tin was identified as an ECOPC for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Non-PMJM Receptors – Small Home Range***

NOAEL HQs, based on the default risk model, were greater than 1 for the mourning dove (insectivore), American kestrel, and deer mouse (insectivore). NOAEL HQs were equal to 1 for the mourning dove (herbivore). LOAEL HQs were less than 1 for all four receptors. Therefore, the potential for adverse effects to populations of the mourning dove (herbivore and insectivore), American kestrel and deer mouse (insectivore) are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Tin samples were available from 37 grid cells (Figure 10.6). NOAEL HQs greater than 1 were calculated in 89 percent of the grid cells, while no LOAEL HQs greater than 1 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to tin.

### 10.1.7 Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate HQs for the mourning dove (insectivore) are presented in Table 10.1. Figure 10.7 shows the spatial distribution of bis(2-ethyhexyl)phthalate in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

***Bis(2-ethylhexyl)phthalate – Risk Description***

There is no identified source in the WBEU of bis(2-ethylhexyl)phthalate, which was identified as an ECOPC for the mourning dove (insectivore) receptor. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Non-PMJM Receptors – Small Home Range***

NOAEL HQs using default risk models were greater than 1 for the mourning dove (insectivore). LOAEL HQs were less than 1 using both Tier 1 and 2 EPCs. Therefore, the potential for adverse effects to populations of the mourning dove (insectivore) from exposure to bis(2-ethylhexyl)phthalate are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Bis(2-ethylhexyl)phthalate samples were available from 34 grid cells (Figure 10.7). NOAEL HQs greater than 1 were calculated in 85 percent of the grid cells, while no grids had LOAEL HQs greater than 1 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to bis(2-ethylhexyl)phthalate.

### 10.1.8 Endrin

Endrin HQs for the American kestrel and mourning dove (insectivore) are presented in Table 10.1. Figure 10.8 shows the spatial distribution of endrin in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

***Endrin – Risk Description***

There is no identified source of endrin in the WBEU. Endrin was identified as an ECOPC for the American kestrel and mourning dove (insectivore) receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Non-PMJM Receptors – Small Home Range***

NOAEL HQs using the default risk model were greater than 1 for the American kestrel and the mourning dove (insectivore). LOAEL HQs were less than or equal to 1 using both Tier 1 and 2 EPCs. Therefore, the potential for adverse effects to populations of the American kestrel and the mourning dove (insectivore) from exposure to endrin are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Endrin samples were available from 34 grid cells (Figure 10.8). NOAEL HQs greater than 1 were calculated in 100 percent of the grid cells. Ninety-seven percent of the grids had LOAEL HQs less than 1, and 3 percent of the grids had LOAEL HQs between 1 and 5 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to endrin.

### 10.1.9 Total PCBs

HQs for total PCBs for the mourning dove (insectivore) are presented in Table 10.1. Figure 10.9 shows the spatial distribution of PCB (total) in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

***PCB (Total) – Risk Description***

There is no identified source for PCBs in the WBEU. Total PCBs were identified as an ECOPC for the mourning dove (insectivore) receptor. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

***Non-PMJM Receptors – Small Home Range***

NOAEL HQs using default risk models were greater than 1 for the mourning dove (insectivore). LOAEL HQs were less than 1 using both Tier 1 and 2 EPCs. Therefore, the potential for adverse effects to populations of the mourning dove (insectivore) from exposure to total PCBs are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Total PCB samples were available from 34 grid cells (Figure 10.9). NOAEL HQs greater than 1 were calculated in 85 percent of the grid cells, while no grids had LOAEL HQs greater than 1 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors indicate low risk from exposure to total PCBs.

## 10.2 Ecosystem Characterization

An ecological monitoring program has been underway since 1991, when baseline data on wildlife species was gathered (Ebasco 1992). The purpose of this long-term program was to monitor specific habitats to provide a sitewide database from which to monitor trends in the wildlife populations at RFETS. Although a comprehensive compilation of monitoring results has not been presented, the annual reports of the monitoring program provide localized information and insights on the general health of the RFETS ecosystem. Permanent transects through three basic habitats were run monthly for more than a decade (K-H 2002). Observations were recorded concerning the abundance, distribution, and diversity of wide-ranging wildlife species, including observations of migratory birds, raptors, coyotes, and deer. Limited data are available for small mammals in WBEU. Small mammal monitoring occurred through several tasks in the monitoring program. The Ecological Monitoring Program (DOE 1995) established permanent transects for small mammal monitoring in three habitat types: xeric grasslands, mesic grasslands, and riparian habitats. PMJM studies established small mammal trapping in nearly all riparian habitats across the site (K-H 1998, 1999, 2000, 2001, 2002).

Migratory birds were tracked during all seasons, but most notably during the breeding season. Over 8 years of bird survey data were collected on 18 permanent transects. Field observations were summarized into species richness and densities by habitat type. Habitats comprised the general categories of grasslands, woodlands, and wetlands. However, summaries in annual reports are grouped by habitat types across RFETS and not within EUs because EU boundaries were determined well after the monitoring program had begun. Additionally, wide-ranging animals may use habitat in several EUs and do not recognize EU boundaries.

Summarizing songbird surveys over the breeding season, diversity indices for RFETS for all habitats combined over 8 years of observations (1991 and 1993 to 1999) show a steady state in diversity of bird communities (K-H 2000). Among habitats, results were similar with the exception of an increasing trend in species richness and a decreasing trend in bird densities in woodland habitats. Woodland bird communities consistently show the highest diversity when compared with bird communities in wetlands and grasslands. The decreasing trend can be mostly attributed to transient species (i.e., those species not usually associated with woody cover) except for red-tailed hawk (*Buteo jamaicensis*) and American goldfinch (*Carduelis tristis*). The red-tailed hawk change in density can be attributed to a loss of nesting sites in Upper Woman Creek during the survey period. Goldfinch abundance can be heavily influenced by the availability of food sources.

A subgroup of migratory birds is the neotropical migrants, which show declining populations in North America (Audubon 2005, Nature Conservancy 2005). Most of this decline is thought to be due to conversion of forest land to agriculture in the tropics, and conversion to real estate development in North America. Grassland birds that are neotropical migrants are also in decline. However, over the last 5 years at RFETS, the declining trends have not been observed and densities for this group show an increase.

Raptors, big game species, and carnivores were observed through relative abundance surveys and multi-species surveys (16 permanent transects) that provide species-specific sitewide counts. Raptors were noted on relative abundance surveys and nest sites were visited repeatedly during the nesting season to confirm nesting success. The three most common raptors at RFETS are red-tailed hawk, great horned owl (*Bubo virginianus*), and American kestrel (*Falco sparverius*) (K-H 2002). One Swainson's hawk nest was noted in North Walnut Creek near the A-1 Pond, and one great horned owl nest was observed within South Walnut Creek. All nests typically fledged two young of each species, except kestrels, which usually fledged two to three young. Each species had a successful nesting season each year during the monitoring period from 1991 to 1999 with a single exception. This exception was the loss of the red-tailed hawk nest in Upper Woman Creek (K-H 1997, 1998) due to weather. The continued presence of nesting raptors at RFETS (K-H 2002) indicates that habitat quality and protection from human disturbance have contributed to making RFETS a desirable location for raptors to reproduce. Adequate habitat provides essential seasonal requirements. RFETS is estimated to be at optimum population density for raptors given available habitat and territorial nature of these species (K-H 2000).

Two deer species inhabit RFETS: mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*). No white-tailed deer were present at RFETS in 1991 when monitoring began (K-H 2002). In 2000 (K-H 2001), the population of white-tailed deer was estimated to be between 10 and 15 individuals. White-tailed deer frequent WBEU but spend the majority of their time in LWOEU. Mule deer frequent all parts of RFETS (14 $mi^2$) year round. The RFETS population from winter counts is estimated at a mean 125 individuals (n = 7), with a density of 14 deer per square mile (K-H 2000, 2002). Winter mule deer counts have varied from 100 to 160 individuals over the monitoring period (1994 to 2000), with expected age/sex class distributions (K-H 2001). The mule deer populations from RFETS have been increasing at a steady state, with good age/sex distributions (K-H 2001) over time and similar densities when compared to other "open" populations that are not hunted. This provides a good indicator that habitat quality is high and that site activities have not affected deer populations. It is unlikely that deer populations are depressed or reproduction is affected by contaminants. A recent study on actinides in deer tissue found that plutonium levels were near or below detection limits (Todd and Sattelberg 2004). This provides further support that the deer population is healthy.

Coyotes (Canis latrans) are the top mammalian predator at RFETS. They prey upon mule deer fawns and other smaller prey species. The number of coyotes using the site has been estimated at 14 to 16 individuals (K-H 2002). Through surveys across the site, coyotes have been noted to have reproduction success with as many as six dens active in 1 year. Typically, at RFETS, three to six coyote dens support an estimated 14 to 16 individuals at any given time (K-H 2001). No coyote dens have ever been found within the WBEU, which is likely due to the large amount of human activities associated with pond management. Coyotes have exhibited a steady population over time, indicating their prey species continue to be abundant and healthy.

The WBEU has been trapped in one location over several years (DOE 1995, K-H 2002) under the Ecological Monitoring Program. Initially (DOE 1995), a monitoring site in xeric tallgrass prairie was established for long-term monitoring. Results from these trapping efforts in spring and fall of 1993 and 1994 revealed a diverse small mammal community with a total of eight species observed. Species densities for each species were recorded at expected and normal levels (DOE 1995, Fitzgerald et. al. 1994). More recent efforts (K-H 2001) abandoned the original robust study design and are not comparable. Although species richness and densities had decreased considerably at this xeric site, the trapping was conducted mid-summer when small mammal distributions are greatly attenuated. Most often, trapping efforts conducted in summer do not resemble the diversity revealed in other seasons. Efforts to trap PMJM have not been attempted in the EU due to the lack of habitat. Results of small mammal trapping from 1993 and 1994 give indications of diverse and healthy small mammal communities in xeric grasslands of the WBEU. Some relatively rare pocket mouse species (CNHP 1999) have also been captured at this site adding to species diversity and indicating native conditions expected in typical arid grasslands on the plains of eastern Colorado (Fitzgerald et al 1994).

The high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and that the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the WBEU.

### 10.3 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually addressed by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. Chemical-specific uncertainties are presented in Attachment 5 of this document and were discussed in terms of their potential effects on the risk characterization in the risk description section for each ECOPC. The following general uncertainties associated with the ERAs for all the EUs may under- or overestimate risk to an unknown degree; a full discussion of these general uncertainties is provided in Volume 2 of Appendix A of the RI/FS Report:

- Uncertainties associated with data quality and adequacy;
- Uncertainties associated with the ECOPC identification process;
- Uncertainties associated with the selection of representative receptors;
- Uncertainties associated with exposure calculations;

- Uncertainties associated with the development of NOAEL ESLs;
- Uncertainties associated with the lack of toxicity data for ECOIs; and
- Uncertainties associated with eliminating ECOIs based on professional judgment.

The following sections are potential sources of general uncertainty that are specific to the WBEU ERA.

### 10.3.1 Uncertainties Associated with Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the WBEU, respectively. A more detailed discussion is presented in Appendix A, Volume 2, Attachments 2 and 3 of the RI/FS Report, and Attachment 2 of this volume. The data quality assessment indicates the data are of sufficient quality for use in the CRA. The adequacy of the WBEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. The assessment indicates the data (except dioxins) meet the data adequacy guidelines for surface soil. No surface soil or sediment samples were collected for dioxins in the WBEU. Although this does not meet the minimal data adequacy guideline, as noted Section 1.2, dioxins are not expected to have been released in the WBEU, and it is possible to make risk management decisions without additional sampling. The data adequacy guideline for number of surface water samples is met for radionuclides, metals, and VOCs, but not for SVOCs and PCBs. However, existing data show SVOCs and PCBs were not detected in surface water in the WBEU, and although SVOCs and PCBs were detected in surface soil and surface sediment in the WBEU and elsewhere at RFETS, they are present at low concentrations in surface water sitewide when detected, and are often non-detected. Therefore, these lines of evidence indicate that SVOCs and PCBs not likely to be detected in the EU surface water, and it is possible to make risk management decisions without additional sampling. Data used in the CRA must have detection limits to allow meaningful comparison to ESLs. When these detection limits exceed the respective ESLs, this is a source of uncertainty in the risk assessment. Attachment 1 to this volume provides a detection limit adequacy screen where detection limits for non-detected analytes as well as analytes detected in less than 5 percent of the samples are compared to ESLs. There are several analytes that have detection limits that exceed PRGs/ESLs in surface soil, sediment, and subsurface soil. However, with the exception of di-n-butylphthalate in surface soil, these analytes contribute a low level of uncertainty to the overall risk estimates because either only a small fraction of the detection limits are greater than the PRGs/ESLs, the maximum detection limits are of the same order of magnitude as the PRGs/ESLs, or professional judgment indicates they are not likely to be ECOPCs in surface soil even if detection limits had been lower. Di-n-butylphthalate has potential to be an ECOPC in the WBEU surface soil based on professional judgment, and it would present a potential for adverse ecological effects if it was detected at its maximum detection limit. Consequently, there is some uncertainty in the overall risk estimates because of the higher detection limits associated with di-n-butylphthalate.

### 10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Wind Blown Area Exposure Unit

Several ECOIs detected in the WBEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology [DOE 2005a]). These ECOIs are listed in Tables 7.1 and 7.9 with a "UT" designation. Included as a subset of the ECOIs with a "UT" designation are the essential nutrients (calcium, iron, magnesium, potassium, and sodium). Although these nutrients may be potentially toxic to certain ecological receptors at high concentrations, the uncertainty associated with the toxicity of these nutrients is expected to be low. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high-quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore, while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

ESLs and/or TRVs were not available for some receptors for the ECOPC identified in Section 7.0. These include terrestrial invertebrates (manganese, silver, thallium, tin, bis[2-ethylhexyl]phthalate, endrin, and PCBs), birds (silver and thallium), and mammals (silver). The risks to these ECOPC/receptor pairs are uncertain. The lack of ESLs for some receptors may tend to underestimate potential risks to ecological receptors. However, the magnitude of this underestimation is likely to be low. Available ESLs for organics show estimated ecological risks to be minimal to low for those receptors where toxicity information is available. This source of uncertainty is not expected to be significant.

### 10.3.3 Uncertainties Associated with Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the WBEU. The weight-of-evidence approach indicates that there is no identified source or pattern of release in the WBEU, and the slightly elevated values of the WBEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation is unlikely to have significant effect on the overall risk calculations because the ECOIs eliminated from further consideration are found at concentrations in WBEU that are at levels that are unlikely to result in risk concerns for ecological receptors and are well within regional background levels. In addition, these ECOIs are not related to site-activities in the WBEU and have very low potential to be transported from historical sources to the WBEU.

## 10.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the general sources of uncertainty discussed tend to either underestimate risk or overestimate risk, many result in an unknown effect on the potential risks. However, the CRA Methodology outlines a tiered process of risk evaluation that includes conservative assumptions for the ECOPC identification process and more realistic assumptions, as appropriate, for risk characterization.

# 11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the WBEU is presented below.

## 11.1 Data Adequacy

The adequacy of the WBEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. Except for SVOCs and PCBs in surface water, and dioxins in surface soil and sediment, the assessment indicates the data meet the data adequacy guidelines. There is limited data for SVOCs and PCBs in surface water. However, other lines of evidence (e.g., information on migration pathways and the concentration levels in the media) indicate that SVOCs and PCBs are not likely to be present in WBEU surface water, and therefore, are not of concern to human or ecological receptors. No surface soil or sediment samples were collected for dioxins in the WBEU. Although this does not meet the minimal data adequacy guideline, as noted Section 1.2, dioxins are not expected to have been released in the WBEU. Therefore, given these data limitations, it is still possible to render risk management decisions using the existing data. In addition, for analytes that are not detected or detected at a frequency less than 5 percent, there are several analytes in surface soil, sediment and subsurface soil that have detection limits that exceed the PRGs/ESLs, but these higher detection limits contribute only minimal uncertainty to the overall risk estimates because either only a small fraction of the detection limits are greater than the PRGs/ESLs, the maximum detection limits are the same order of magnitude as the PRGs/ESLs, or professional judgment indicates they are not likely to be ECOPCs in surface soil even if detection limits had been lower. The only exception is di-n-butylphthalate, which has potential to be an ECOPC in the WBEU surface soil based on professional judgment, and it would present a potential for adverse ecological effects if it was detected at its maximum detection limit. Consequently, there is some uncertainty in the overall risk estimates because of the higher detection limits associated with di-n-butylphthalate.

## 11.2 Human Health Risk

An HHRA was performed for the WBEU for analytes identified as COCs. The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in WBEU media to PRGs for the WRW receptor. Inorganic and radionuclide analytes with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic and radionuclide analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG, were carried forward to professional judgment evaluation. Based on the COC selection process, arsenic and plutonium-239/240 were selected as COCs for surface soil/surface sediment. No COCs were selected for subsurface soil/subsurface sediment.

For the WRW, the estimated total excess lifetime chemical cancer risk from arsenic in surface soil/surface sediment at the WBEU is 2E-06, based on both the Tier 1 and Tier 2 EPCs. The estimated noncarcinogenic HI is 0.02, based on the Tier 1 EPC, and 0.01, based on the Tier 2 EPC. The estimated total excess lifetime radionuclide cancer risk to the WRW is 2E-06, based on the Tier 1 EPC, and 9E-07, based on the Tier 2 EPC.

For the WRV, estimated total excess lifetime chemical cancer risk, based on the Tier 1 EPC, at the WBEU is 2E-06; the risk based on the Tier 2 EPC is 1E-06. The estimated noncarcinogenic HI is 0.01 based on the Tier 1 and 0.008 based on the Tier 2 EPC. The estimated total excess lifetime radionuclide cancer risk to the WRV is 1E-06, based on the Tier 1 EPC, and 6E-07, based on the Tier 2 EPC.

The results of the Tier 1 and Tier 2 dose assessments indicate that estimated doses are less than 1 mrem (Table 5.2 and Table 5.4), which are well below the radiation dose limit of 25 mrem.

Although selected as a COC for the HHRA, arsenic has not been directly associated with historical IHSSs and is likely due to natural variation. Background arsenic concentrations in the surface soil/surface sediment at RFETS range from 0.27 to 9.6 mg/kg. Therefore, under similar exposure conditions as those evaluated for the WBEU, background risks from arsenic in surface soil/surface sediment would be 70 to 80 percent of that estimated for the WBEU, or approximately 1.4E-06 to 1.5E-06.

The risk characterization for exposure of the WRW and WRV to surface soil/surface sediment indicated that the estimated cancer risks for both receptor populations were at or below the $10^{-6}$ to $10^{-4}$ risk range and that estimated HIs were well below 1, indicating that significant noncancer health effects are unlikely.

## 11.3 Ecological Risk

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ECOIs that are present in the WBEU. The ECOPC identification process is described in the CRA Methodology (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. Chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total PCBs were identified as ECOPCs for representative populations of non-PMJM receptors in surface soil. Only small portions of PMJM habitat are currently located in the WBEU. These habitat patches are evaluated in either the UWNEU or LWOEU because the patches for PMJM within the WBEU are a small subset of the larger PMJM patches in these two adjacent EUs (Figure 1.5). Therefore, no ECOPCs were identified for individual PMJM receptors in surface soil. Although there are no dioxin data for surface soil, the evaluation of site-wide data indicate dioxins are not expected to be present in WBEU surface soil, however, there is some uncertainty in the overall risk estimates for the WBEU as a result of this data limitation. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology. Tier 1 and Tier 2 EPCs were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. In addition, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models were completed for several ECOPCs to provide a refined estimate of potential risk.

Using Tier 1 EPCs and default exposure and risk assumptions, NOAEL HQs ranged from 78 (chromium/terrestrial invertebrate) to less than 1 (chromium III/deer mouse-insectivore). NOAEL HQs also ranged from 57 (chromium/terrestrial invertebrate) to less than 1 (chromium III/deer mouse-insectivore) using Tier 2 EPCs and default exposure and risk assumptions (Table 10.1).

For terrestrial plants, the chromium HQ was greater than 1 using the Tier 1 and Tier 2 EPCs. However, there is low confidence placed in the chromium ESL for terrestrial plants and additional no observed effect concentration (NOEC) and lowest observed effects concentration (LOEC) values were available in the literature. Using the additional NOEC ESL, HQs were greater than 1, while no HQs greater than 1 were calculated using the additional LOEC ESL. As discussed in Attachment 5, the LOEC ESL is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight. Based on the refined analysis and the low confidence in the default ESL, it is reasonable to assume that the potential for adverse effects to terrestrial plant populations from exposure to chromium are likely to be low in the WBEU.

For terrestrial invertebrates, the chromium HQ was greater than 1 using the Tier 1 and Tier 2 EPCs. However, this ESL is based on survival effects for earthworms exposed to chromium VI. There is uncertainty in the use of this ESL because chromium III is the more prevalent form of chromium found in soils. Using a LOEC based on chromium III, HQs were less than 1 using both the Tier 1 and Tier 2 EPCs. As discussed in Attachment 5, this LOEC is representative of a concentration at which there is a 30 percent reduction in earthworm growth. The low confidence placed on the ESL based on chromium VI and the lack of an HQ greater than 1 using the LOEC ESL, indicates that the potential for adverse effects to terrestrial invertebrate populations from exposure to chromium in surface soils is likely to be low in the WBEU.

Most of the ECOPC/receptor pairs for birds and mammals had lowest observed adverse effect level (LOAEL) HQs less than or equal to 1 using the default assumptions in the risk calculations. However, the following ECOPC/receptor pairs had LOAEL HQs greater than 1 using the default exposure and toxicity assumptions:

- Chromium/mourning dove (insectivore) - LOAEL HQs were greater than 1 (HQs = 5 and 3 using Tier 1 and Tier 2 EPCs, respectively) based on the default risk model. Using a median bioaccumulation factor (BAF) rather than an upper-bound

BAF for the estimation of invertebrate tissue concentrations, no LOAEL HQs greater than 1 were calculated. Based on these additional risk calculations using the median BAF, the potential for adverse effects to the mourning dove (insectivore) populations in the WBEU are likely to be low.

- Nickel/deer mouse (insectivore) – LOAEL HQs were greater than 1 (HQs = 6 and 4 using Tier 1 and Tier 2 EPCs, respectively) based on the default risk model. Using a median BAF rather than an upper-bound BAF for the estimation of invertebrate tissue concentrations, no LOAEL HQs greater than 1 were calculated. In addition, HQs were also calculated using additional TRVs from the literature. No HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV in the refined analysis. Based on these refined risk calculations using the median BAF or additional TRVs, the potential for adverse effects to the mourning dove (insectivore) populations in the WBEU are likely to be low.

Based on default and refined calculations, site-related risks are likely to be low for the ecological receptors evaluated in the WBEU (Table 11.1). In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data, and therefore, there are no ecological contaminants of concern (ECOCs) for the WBEU.

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# TABLES

**Table 1.1**
**WBEU IHSSs**

| IHSS | PAC/UBC | Name | Description | Disposition |
|---|---|---|---|---|
| 109 | 900-109 | Trench T-2 - Ryan’s Pit | The Trench T-2 site was used prior to 1968 for the disposal of sanitary sewage sludge and some flattened drums. Approximately 200 cubic yards of contaminated material was removed from the trench. The excavated soil was treated with a low temperature thermal desorption unit (TDU) and returned to the pit as “clean” backfill in September 1996. | NFAA-2002, HRR |
| 110 | NE-110 | Trench T-3 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Action was taken consisting of excavating approximately 5,000 cubic yards of material from Trenches T-3 and T-4, followed by thermal desorption processing of the material. The processed material was returned to Trench T-3 enveloped in a geotextile fabric. | NFAA-2002, HRR |
| 111.1 | NE-111.1 | Trench T-4 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Action was taken consisting of excavating approximately 5,000 cubic yards of material from Trenches T-3 and T-4, followed by thermal desorption processing of the material. The processed material was returned to Trench T-3 enveloped in a geotextile fabric. In 2004, a surface soil hot spot was identified and removed at Trench T-4. | NFAA-2003, HRR; NFAA-2005, HRR |
| 111.2 | NE-111.2 | Trench T-5 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required. | NFAA-2005, HRR |
| 111.3 | NE-111.3 | Trench T-6 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Removed a total of 420 cy from T-6 and T-8 per ER RSOP Notification #04-13 in 2004. | NFAA-2005, HRR |
| 111.4 | NE-111.4 | Trench T-7 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. A surface soil hot spot was removed in 2004. | NFAA-2003, HRR; NFAA-2005, HRR |
| 111.5 | NE-111.5 | Trench T-8 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Removed a total of 420 cy from T-6 and T-8 per ER RSOP Notification #04-13 in 2004. | NFAA-2005, HRR |
| 111.6 | NE-111.6a | Trench T-9a | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required. | NFAA-2005, HRR |
| 111.6 | NE-111.6b | Trench T-9b | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required. | NFAA-2005, HRR |
| 111.7 | NE-111.7 | Trench T-10 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required. | NFAA-2005, HRR |
| 111.8 | NE-111.8 | Trench T-11 | Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required. | NFAA-2005, HRR |

**Table 1.1**
**WBEU IHSSs**

| IHSS | PAC/UBC | Name | Description | Disposition |
|---|---|---|---|---|
| 112 | 900-112 | 903 Pad | The 903 Pad was used from October 1958 to January 1967 for storage of radioactively contaminated oil drums. Approximately three-fourths of the drums were plutonium contaminated, while most of the balance contained uranium. Most drums contained lathe coolant oil and carbon tetrachloride. Other liquids including hydraulic oils, vacuum pump oil, trichloroethylene, perchloroethylene, silicone oils, and acetone still bottoms were also contained in the drums. Removal of all drums and wastes was completed in 1968, and the site was capped with asphalt in 1969. Removed 20,213 cy of radionuclide contaminated soil and 4467 cy of asphalt per ER RSOP Notification #02-09 in 2004. | NFAA-2005, HRR |
| 119.2 | 900-119.2 | East Scrap Metal Storage Area and Solvent Spill | This site was one of two areas east of former Building 881 along the southern perimeter road, which was used as a barrel storage area. The barrels contained unknown quantities and types of solvents and wastes. All barrels were removed from the site in 1972. The site was also used for scrap metal storage. No action required. | OU 1 CAD/ROD |
| 140 | 900-140 | Hazardous Disposal Area (IAG Name: Reactive Metal Destruction Site) | In the 1950s and 1960s, approximately 400 to 500 lb of metallic lithium were disposed on the ground surface by sprinkling with water to initiate a chemical reaction that results in the generation of lithium hydroxide plus hydrogen gas. Other reactive metals were disposed in a similar manner. No action required. | NFAA-2005, HRR |
| 155 | 900-155 | 903 Lip Area | Plutonium redistributed from the 903 Drum Storage Site by wind and surface water was deposited in the 903 Lip Area. Soil clean-up efforts were undertaken at the Lip Site in 1976, 1978 and 1984. After the 1984 effort, the excavated area was backfilled with clean topsoil. Removed 49,800 cy of radionuclide-contaminated soil per ER RSOP Notification #03-07 and IHSS Group 900-11 IM/IRA . | NFAA-2005, HRR |
| 183 | 900-183 | Gas Detoxification Area | An area south of the 903 Pad was used between approximately 1963 and 1983 to detoxify various gases from lecture bottles using commercial neutralization processes. The gases consisted of nitrogen oxides, chlorine, hydrogen sulfide, sulfur tetrafluoride, methane, hydrogen fluoride and ammonia. No action required. | NFAA-2002, HRR |
| 216.2 | NE-216.2 | East Spray Field | This area was used for spray evaporation of sewage treatment plant effluent. No action required. | NFAA-2003, HRR |
| 216.3 | NE-216.3 | East Spray Field | This area was used for spray evaporation of sewage treatment plant effluent. No action required. | NFAA-2003, HRR |
| N/A | 000-501 | Roadway Spraying | Roadways in the BZ OU were occasionally sprayed with waste oils for dust suppression, but sometimes reverse osmosis brine solutions and footing drain water were also applied. No action required. | NFAA-2002, HRR |
| N/A | NE-1401 | NE Buffer Zone Gas Line Break | A 12-inch high-pressure natural gas line was ruptured by a bulldozer during ditch construction in the southeast buffer zone. Approximately five million cubic feet of natural gas were released to the environment. No action required. | NFAA-2002, HRR |
| N/A | NE-1402 | East Inner Gate PCB Spill | Oil containing PCBs leaked onto the asphalt at the east gate from a commercial truck that intended to pick up a shipment of PCB wastes from the plant. The truck left without entering the plant. No action required. | NFAA-2002, HRR |
| N/A | NE-1403 | Gasoline Spill - Building 920 Guard Post | Approximately 1 quart of gasoline spilled from the portable generator just east of the Building 920 Guard Post. The spill was a result of a defective fuel level gauge. No action required. | NFAA-2002, HRR |

**Table 1.1**
**WBEU IHSSs**

| IHSS | PAC/UBC | Name | Description | Disposition |
|---|---|---|---|---|
| N/A | NE-1412 | Trench T-12 Located in OU 2 East Trenches | PAC NE-1412 (Trench T-12) was used primarily for the disposal of sanitary wastewater treatment plant sludge. Trenches T-11 and T-12 were identified during a 1993 evaluation of aerial photographs taken on April 15, 1966 and April 29, 1967. They are believed to be approximately 10 feet deep and covered with several feet of fill. The waste streams and potential contaminants are similar to those reported for the trenches in the East Trenches area. No action required. | NFAA-2003, HRR |
| N/A | NE-1413 | Trench T-13 Located in OU 2 East Trenches | PAC NE-1413 (Trench T-13) was used primarily for the disposal of sanitary wastewater treatment plant sludge. No action required. | NFAA-2003, HRR |
| N/A | SE-1602 | East Firing Range | The East Firing Range included two target areas where handgun, shotgun, and rifle bullets of various caliber, as well as depleted uranium armor-piercing bullets were fired into the hillside or into soil berms, potentially releasing antimony, arsenic, lead, and depleted uranium into the soil. Removed 520 cy of metal-contaminated soil per IHSS Group 900-11 IM/IRA. | NFAAA-2005, HRR |

**Table 1.2**
**Number of Samples Collected in Each Medium by Analyte Suite**

| Analyte Suite | Surface Soil/Surface Sediment[a] | Subsurface Soil/Subsurface Sediment[a] | Surface Soil[b] | Subsurface Soil[b] |
|---|---|---|---|---|
| Inorganic | 160 | 314 | 151 | 313 |
| Organic | 107 | 580 | 98 | 579 |
| Radionuclide | 347 | 417 | 335 | 414 |

[a] Used in the HHRA.

[b] Used in the ERA.

Note: The total number of results (samples) in Tables 1.3 through 1.6 may differ from the total number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

**Table 1.3**
**Summary of Detected Analytes in Surface Soil/Surface Sediment**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[b] |
|---|---|---|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | | | | |
| Aluminum | 0.24 - 200 | 160 | 100 | | | 4,570 | 33,000 | 14,370 | 6,852 |
| Ammonia | 0.300 | 9 | 100 | | | 1.09 | 3.33 | 2.07 | 0.845 |
| Antimony[c] | 0.27 - 60 | 138 | 17.4 | 0.270 | 19.3 | 0.300 | 0.880 | 2.72 | 2.72 |
| Arsenic | 0.16 - 10 | 160 | 100 | | | 1 | 11 | 5.20 | 2.12 |
| Barium | 0.039 - 200 | 160 | 100 | | | 34.9 | 280 | 134 | 47.2 |
| Beryllium | 0.031 - 5 | 160 | 68.8 | 0.280 | 1.30 | 0.230 | 1.40 | 0.684 | 0.285 |
| Boron | 0.35 - 1.2 | 76 | 93.4 | 0.350 | 2.70 | 0.670 | 15 | 6.82 | 3.63 |
| Cadmium | 0.03 - 5 | 159 | 42.8 | 0.0300 | 1.30 | 0.0650 | 2.60 | 0.497 | 0.350 |
| Calcium | 1 - 5,000 | 160 | 100 | | | 1,740 | 185,000 | 21,387 | 38,037 |
| Cesium | 86.4 - 1,000 | 66 | 19.7 | 6.80 | 211 | 0.680 | 7.40 | 34.4 | 29.8 |
| Chromium | 0.053 - 10 | 160 | 100 | | | 2.20 | 80.5 | 16.1 | 10.2 |
| Cobalt | 0.079 - 50 | 160 | 100 | | | 2.20 | 21.6 | 6.61 | 2.41 |
| Copper | 0.045 - 25 | 159 | 100 | | | 2.20 | 49.8 | 14.8 | 6.09 |
| Iron | 0.68 - 100 | 160 | 100 | | | 3,680 | 27,000 | 14,299 | 5,207 |
| Lead | 0.12 - 3 | 160 | 100 | | | 3 | 120 | 33.6 | 20.2 |
| Lithium | 0.17 - 100 | 140 | 92.1 | 2 | 14.1 | 4.40 | 33 | 12.2 | 6.20 |
| Magnesium | 1.6 - 5,000 | 160 | 100 | | | 1,100 | 8,270 | 3,142 | 1,297 |
| Manganese | 0.033 - 15 | 160 | 100 | | | 54 | 1,200 | 283 | 144 |
| Mercury | 0.0012 - 0.2 | 141 | 48.9 | 0.0120 | 0.200 | 0.00560 | 0.250 | 0.0456 | 0.0350 |
| Molybdenum | 0.13 - 200 | 146 | 29.5 | 0.130 | 5.20 | 0.150 | 6.10 | 1.19 | 1.17 |
| Nickel | 0.19 - 40 | 160 | 96.9 | 8.80 | 9.60 | 4.40 | 101 | 14.6 | 10.0 |
| Nitrate / Nitrite | 0.2 - 1.8 | 18 | 88.9 | 1.60 | 1.80 | 0.738 | 3.83 | 2.14 | 0.944 |
| Potassium | 36 - 5,000 | 160 | 99.4 | 954 | 954 | 690 | 6,200 | 3,006 | 1,264 |
| Selenium | 0.24 - 5 | 158 | 21.5 | 0.200 | 4.50 | 0.260 | 0.880 | 0.415 | 0.386 |
| Silica | 2.7 - 5.3 | 76 | 100 | | | 175 | 1,100 | 596 | 202 |
| Silicon[c] | 0 - 100 | 46 | 100 | | | 81 | 2,160 | 1,076 | 694 |
| Silver | 0.055 - 10 | 151 | 23.8 | 0.0550 | 5.70 | 0.0810 | 42.8 | 1.27 | 4.09 |
| Sodium | 5.7 - 5,000 | 160 | 31.3 | 46.3 | 594 | 46 | 492 | 101 | 71.0 |
| Strontium | 0.0061 - 200 | 146 | 100 | | | 8.90 | 362 | 47.3 | 46.0 |
| Thallium | 0.32 - 10 | 160 | 20 | 0.200 | 2.20 | 0.210 | 3.30 | 0.409 | 0.404 |
| Tin | 0.24 - 200 | 146 | 17.8 | 0.860 | 52.3 | 1.30 | 77.2 | 8.41 | 12.4 |
| Titanium | 0.077 - 0.2 | 76 | 100 | | | 33 | 603 | 275 | 129 |
| Uranium | 1.4 - 7.2 | 76 | 5.26 | 1.40 | 7.20 | 1.90 | 8 | 1.89 | 1.41 |
| Vanadium | 0.25 - 50 | 160 | 100 | | | 12.1 | 72 | 32.0 | 12.0 |
| Zinc | 0.2 - 20 | 160 | 100 | | | 15 | 216 | 52.8 | 23.7 |
| **Organics (µg/kg)** | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane[c] | 4.86 - 12 | 21 | 4.76 | 0.899 | 12 | 1.39 | 1.39 | 1.74 | 1.70 |
| 1,2,3-Trichloropropane[c] | 4.86 - 5.5 | 13 | 7.69 | 0.965 | 1.09 | 1.47 | 1.47 | 0.583 | 0.267 |
| 1,2,4-Trimethylbenzene | 4.86 - 5.5 | 13 | 7.69 | 0.949 | 1.07 | 1.44 | 1.44 | 0.574 | 0.261 |
| 2-Butanone | 10 - 110 | 21 | 4.76 | 9.29 | 24 | 19 | 19 | 6.42 | 3.36 |
| 4,4'-DDE | 1.7 - 38 | 49 | 6.12 | 9.50 | 38 | 4 | 5.80 | 9.41 | 2.20 |
| 4,6-Dinitro-2-methylphenol | 130 - 3,900 | 88 | 1.14 | 1,600 | 4,100 | 390 | 390 | 1,002 | 318 |
| Acenaphthene | 33 - 780 | 94 | 6.38 | 340 | 780 | 45 | 240 | 186 | 38.5 |
| Acetone[c] | 10 - 110 | 21 | 9.52 | 11 | 130 | 35 | 71 | 13.8 | 19.1 |
| Aldrin | 2.1 - 19 | 49 | 2.04 | 8.10 | 19 | 0 | 0 | 4.80 | 1.12 |
| alpha-Chlordane | 80 - 190 | 45 | 2.22 | 80 | 190 | 0 | 0 | 47.4 | 11.3 |
| Anthracene | 25 - 780 | 94 | 8.51 | 340 | 780 | 47 | 330 | 189 | 40.1 |
| Aroclor-1248 | 6.2 - 240 | 90 | 1.11 | 0.759 | 12 | 840 | 840 | 47.8 | 93.2 |
| Aroclor-1254 | 4.4 - 380 | 90 | 28.9 | 340 | 820 | 6.80 | 3,000 | 116 | 321 |
| Aroclor-1260 | 4.9 - 380 | 90 | 15.6 | 340 | 820 | 6.20 | 240 | 70.8 | 57.5 |
| Benzene[c] | 4.86 - 12 | 21 | 4.76 | 340 | 820 | 1.44 | 1.44 | 1.70 | 1.73 |
| Benzo(a)anthracene | 26 - 780 | 94 | 24.5 | 340 | 820 | 39 | 830 | 198 | 111 |
| Benzo(a)pyrene | 43 - 780 | 94 | 14.9 | 340 | 820 | 48 | 750 | 211 | 90.4 |
| Benzo(b)fluoranthene | 31 - 780 | 94 | 14.9 | 1,600 | 4,100 | 40 | 810 | 215 | 95.2 |
| Benzo(g,h,i)perylene | 29 - 780 | 94 | 8.51 | 8.10 | 19 | 82 | 240 | 203 | 59.5 |
| Benzo(k)fluoranthene | 34 - 780 | 94 | 10.6 | 340 | 820 | 69 | 740 | 216 | 91.9 |
| Benzoic Acid | 300 - 3,900 | 88 | 30.7 | 0.918 | 12 | 77 | 1,100 | 810 | 468 |
| beta-BHC | 1.8 - 19 | 49 | 2.04 | 340 | 820 | 0 | 0 | 4.76 | 1.08 |
| bis(2-ethylhexyl)phthalate | 71 - 780 | 94 | 14.9 | 8.10 | 19 | 49 | 1,400 | 223 | 153 |
| Chlorobenzene[c] | 4.86 - 12 | 21 | 4.76 | 340 | 820 | 2.03 | 2.03 | 1.78 | 1.69 |

**Table 1.3**
**Summary of Detected Analytes in Surface Soil/Surface Sediment**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[b] |
|---|---|---|---|---|---|---|---|---|---|
| Chrysene | 30 - 780 | 94 | 28.7 | 340 | 820 | 39 | 790 | 196 | 109 |
| delta-BHC | 0.59 - 19 | 49 | 2.04 | 340 | 820 | 0 | 0 | 4.76 | 1.08 |
| Dibenz(a,h)anthracene | 26 - 780 | 94 | 4.26 | 340 | 820 | 43 | 92 | 203 | 68.2 |
| Dibenzofuran | 38 - 780 | 94 | 2.13 | 9.10 | 47 | 37 | 86 | 205 | 65.3 |
| Dieldrin | 2.9 - 38 | 49 | 4.08 | 8.10 | 19 | 4.30 | 5.80 | 10.2 | 3.41 |
| Di-n-butylphthalate | 22 - 780 | 94 | 6.38 | 9.50 | 38 | 39 | 1,000 | 206 | 106 |
| Di-n-octylphthalate | 37 - 780 | 94 | 1.06 | 0.987 | 12 | 210 | 210 | 207 | 61.5 |
| Endosulfan I | 2 - 19 | 49 | 2.04 | 340 | 790 | 0 | 0 | 4.76 | 1.08 |
| Endrin | 2 - 38 | 49 | 6.12 | 340 | 820 | 4.50 | 5.10 | 9.39 | 2.18 |
| Ethylbenzene[c] | 4.86 - 12 | 21 | 4.76 | 85 | 130 | 1.29 | 1.29 | 1.76 | 1.68 |
| Fluoranthene | 24 - 780 | 93 | 44.1 | 8.10 | 19 | 45 | 1,900 | 237 | 240 |
| Fluorene | 36 - 780 | 94 | 4.26 | 8.10 | 38 | 54 | 230 | 205 | 65.7 |
| gamma-Chlordane | 85 - 130 | 6 | 16.7 | 340 | 820 | 0 | 0 | 45.3 | 24.2 |
| Heptachlor | 2.5 - 19 | 49 | 2.04 | 18 | 190 | 0 | 0 | 4.76 | 1.08 |
| Heptachlor epoxide | 1.9 - 19 | 49 | 2.04 | 1.04 | 57 | 0 | 0 | 5.88 | 3.92 |
| Indeno(1,2,3-cd)pyrene | 24 - 780 | 94 | 9.57 | 340 | 820 | 72 | 220 | 203 | 67.2 |
| Methoxychlor | 0.91 - 190 | 49 | 6.12 | 0.765 | 820 | 3 | 9.40 | 45.5 | 14.5 |
| Methylene Chloride | 4.86 - 12 | 21 | 9.52 | 34 | 730 | 11 | 14 | 4.27 | 6.88 |
| Naphthalene[c] | 4.86 - 780 | 107 | 0.935 | 34 | 260 | 0.890 | 0.890 | 182 | 89.3 |
| N-Nitroso-di-n-propylamine | 24 - 780 | 94 | 1.06 | 34 | 730 | 400 | 400 | 210 | 64.8 |
| Phenanthrene | 37 - 780 | 94 | 35.1 | 340 | 820 | 40 | 1,600 | 216 | 193 |
| Pyrene | 41 - 780 | 94 | 56.4 | 340 | 820 | 43 | 1,800 | 221 | 239 |
| Tetrachloroethene | 4.86 - 12 | 21 | 4.76 | 1.18 | 12 | 1.73 | 1.73 | 1.84 | 1.63 |
| Toluene[b] | 4.86 - 12 | 21 | 4.76 | 1.22 | 12 | 2.26 | 2.26 | 1.88 | 1.62 |
| **Radionuclides (pCi/g)[d]** | | | | | | | | | |
| Americium-241 | 0 - 0.261 | 290 | N/A | | | 0 | 15.6 | 1.81 | 2.42 |
| Cesium-134 | 0.0271 - 0.2 | 35 | N/A | | | -0.0101 | 0.200 | 0.0363 | 0.0537 |
| Cesium-137 | 0.03 - 0.21 | 37 | N/A | | | 0.0500 | 2.01 | 0.781 | 0.565 |
| Gross Alpha | 2.2 - 56 | 49 | N/A | | | -9.70 | 320 | 36.0 | 53.6 |
| Gross Beta | 1 - 21 | 56 | N/A | | | 4.95 | 64 | 33.2 | 8.88 |
| Plutonium-238 | 0.0284 - 0.211 | 9 | N/A | | | 0.102 | 1.53 | 0.447 | 0.454 |
| Plutonium-239/240 | 0 - 0.288 | 319 | N/A | | | -0.00292 | 49 | 9.19 | 12.0 |
| Radium-226 | 0.15 - 0.5 | 36 | N/A | | | 0.590 | 2.19 | 1.10 | 0.281 |
| Radium-228 | 0.06 - 0.69 | 17 | N/A | | | 0.940 | 3.50 | 2.09 | 0.693 |
| Strontium-89/90 | 0.04 - 0.99 | 17 | N/A | | | -0.300 | 1.46 | 0.387 | 0.480 |
| Uranium-233/234 | 0 - 0.674 | 204 | N/A | | | 0.119 | 7.96 | 1.11 | 0.792 |
| Uranium-235 | 0 - 0.448 | 203 | N/A | | | -0.0431 | 0.680 | 0.0802 | 0.0905 |
| Uranium-238 | 0 - 0.438 | 204 | N/A | | | 0.300 | 3.78 | 1.11 | 0.463 |

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

**Table 1.4**
**Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[c] |
|---|---|---|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | | | | |
| Aluminum | 1.1 - 40 | 310 | 100 | | | 1,050 | 54,000 | 13,177 | 7,727 |
| Ammonia | 0.300 | 62 | 22.6 | 0.321 | 0.379 | 0.353 | 1.44 | 0.289 | 0.269 |
| Antimony | 0.16 - 12 | 304 | 15.5 | 0.270 | 32.2 | 0.210 | 350 | 4.58 | 25.5 |
| Arsenic | 0.23 - 2 | 310 | 98.1 | 0.400 | 6.80 | 0.820 | 25.9 | 5.20 | 3.12 |
| Barium | 0.03 - 40 | 310 | 99.7 | 56.3 | 56.3 | 9.20 | 838 | 114 | 99.2 |
| Beryllium | 0.03 - 1 | 310 | 80.3 | 0.0310 | 0.982 | 0.0650 | 2.30 | 0.697 | 0.420 |
| Boron | 0.34 - 1.2 | 162 | 78.4 | 0.350 | 1.50 | 0.600 | 15 | 4.18 | 3.85 |
| Cadmium | 0.03 - 1.96 | 287 | 35.2 | 0.0470 | 2.90 | 0.0520 | 58.7 | 0.864 | 3.86 |
| Calcium | 1.1 - 2,000 | 310 | 100 | | | 1,240 | 260,000 | 40,524 | 54,488 |
| Cesium | 89.5 - 200 | 142 | 64.8 | 7.10 | 120 | 0.640 | 21 | 8.70 | 14.1 |
| Chromium | 0.04 - 2 | 310 | 100 | | | 2.90 | 4,600 | 32.6 | 261 |
| Cobalt | 0.04 - 10 | 310 | 96.1 | 0.710 | 7.80 | 0.720 | 24 | 5.44 | 3.31 |
| Copper | 0.043 - 5 | 310 | 99.0 | 3.60 | 10.6 | 2.10 | 180 | 13.9 | 15.1 |
| Iron | 0.57 - 20 | 310 | 100 | | | 2,250 | 152,000 | 13,131 | 10,282 |
| Lead | 0.12 - 19.63 | 310 | 99.7 | 19.6 | 19.6 | 1.50 | 8,500 | 42.8 | 484 |
| Lithium | 0.17 - 20 | 304 | 93.1 | 1 | 13.9 | 1.10 | 44 | 11.0 | 6.70 |
| Magnesium | 1.2 - 2,000 | 310 | 99.7 | 3,080 | 3,080 | 364 | 12,200 | 3,161 | 1,622 |
| Manganese | 0.03 - 3 | 310 | 100 | | | 15.8 | 1,300 | 193 | 181 |
| Mercury | 0.0012 - 0.2 | 309 | 63.4 | 0.00140 | 0.240 | 0.00150 | 3.40 | 0.0968 | 0.344 |
| Molybdenum | 0.13 - 40 | 304 | 50 | 0.130 | 9.82 | 0.140 | 1,970 | 7.97 | 113 |
| Nickel | 0.03 - 8 | 310 | 98.7 | 0.690 | 8 | 2.70 | 1,330 | 24.1 | 80.5 |
| Nitrate / Nitrite | 0.2 - 0.21 | 66 | 66.7 | 0.214 | 9.73 | 0.238 | 43.6 | 1.92 | 6.23 |
| Phosphorus | N/A | 1 | 100 | | | 160 | 160 | 160 | 0 |
| Potassium | 1.2 - 2,000 | 309 | 97.1 | 259 | 658 | 300 | 13,000 | 1,929 | 1,587 |
| Selenium | 0.18 - 49.08 | 310 | 4.84 | 0.200 | 49.1 | 0.230 | 1.50 | 0.380 | 1.39 |
| Silica | 2.6 - 5.9 | 162 | 100 | | | 174 | 1,200 | 600 | 226 |
| Silicon | 0 - 200 | 75 | 96 | 10.9 | 16.9 | 6 | 2,210 | 361 | 440 |
| Silver | 0.04 - 2.94 | 309 | 19.7 | 0.0400 | 5 | 0.0640 | 219 | 2.16 | 13.6 |
| Sodium | 2.4 - 2,000 | 309 | 51.8 | 39.4 | 472 | 36.9 | 3,700 | 217 | 430 |
| Strontium | 0.0061 - 400 | 309 | 99.0 | 21.8 | 60.9 | 6.20 | 459 | 61.4 | 60.0 |
| Sulfide | 10 - 16.3 | 66 | 10.6 | 10.5 | 22.6 | 12 | 83.5 | 8.08 | 9.74 |
| Thallium | 0.25 - 29.45 | 310 | 34.8 | 0.200 | 29.4 | 0.220 | 10.8 | 0.638 | 1.09 |
| Tin | 0.39 - 40 | 303 | 24.8 | 0.700 | 73.2 | 0.570 | 110 | 7.02 | 11.7 |
| Titanium | 0.083 - 0.24 | 163 | 100 | | | 38.7 | 650 | 225 | 149 |
| Total Petroleum Hydrocarbons | 1 - 30 | 27 | 63.0 | 5.86 | 37 | 6.21 | 249 | 64.5 | 76.3 |
| Uranium | 1.3 - 1.9 | 162 | 29.0 | 1.30 | 1.70 | 1.70 | 19 | 1.80 | 2.21 |
| Vanadium | 0.06 - 10 | 310 | 99.7 | 21 | 21 | 4.60 | 72 | 28.8 | 14.2 |
| Zinc | 0.03 - 4 | 310 | 99.7 | 20 | 20 | 5.30 | 550 | 34.2 | 38.6 |
| **Organics (µg/kg)** | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.1 - 1,500 | 496 | 2.22 | 0.778 | 5,500 | 1 | 300 | 24.8 | 181 |
| 1,1,2,2-Tetrachloroethane | 0.62 - 1,500 | 486 | 0.412 | 0.522 | 5,500 | 22 | 72 | 25.0 | 183 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.12 - 2,100 | 284 | 0.352 | 0.888 | 5,500 | 0.800 | 0.800 | 35.9 | 233 |
| 1,1-Dichloroethene | 0.31 - 1,500 | 491 | 0.407 | 0.632 | 5,500 | 1 | 7 | 25.0 | 182 |
| 1,2,3-Trichlorobenzene | 0.4 - 840 | 279 | 1.79 | 0.637 | 5,500 | 0.630 | 3.70 | 36.0 | 235 |
| 1,2,4-Trichlorobenzene | 0.26 - 790 | 409 | 0.733 | 0.753 | 3,600 | 0.510 | 14 | 92.0 | 203 |
| 1,2,4-Trimethylbenzene | 0.12 - 790 | 279 | 4.66 | 0.586 | 5,500 | 0.120 | 11.8 | 36.1 | 235 |
| 1,2-Dichlorobenzene | 0.099 - 790 | 415 | 0.482 | 0.497 | 3,600 | 0.190 | 0.640 | 90.6 | 202 |
| 1,2-Dichloroethene | 5 - 1,500 | 156 | 2.56 | 5 | 1,500 | 2 | 110 | 8.80 | 60.4 |
| 1,3,5-Trimethylbenzene | 0.52 - 790 | 279 | 1.79 | 0.530 | 5,500 | 1.10 | 4.70 | 36.0 | 235 |
| 1,3-Dichlorobenzene | 0.41 - 790 | 410 | 0.244 | 0.500 | 3,600 | 0.720 | 0.720 | 91.7 | 203 |
| 1,4-Dichlorobenzene | 0.62 - 790 | 410 | 0.732 | 0.924 | 3,600 | 0.870 | 84 | 90.7 | 203 |
| 2-Butanone | 1.7 - 11,300 | 467 | 6.00 | 5 | 15,000 | 1.70 | 8,100 | 123 | 765 |
| 2-Chlorophenol | 10 - 3,800 | 249 | 0.402 | 330 | 77,000 | 46 | 46 | 402 | 2,436 |
| 2-Hexanone[c] | 0.6 - 5,630 | 471 | 0.212 | 5 | 22,000 | 0.800 | 0.800 | 89.5 | 745 |
| 2-Methylnaphthalene | 10 - 3,600 | 249 | 2.01 | 330 | 3,900 | 57 | 83,000 | 676 | 5,491 |
| 4-Chloro-3-methylphenol | 10 - 3,800 | 249 | 0.402 | 330 | 150,000 | 37 | 37 | 660 | 4,754 |
| 4-Isopropyltoluene[c] | 0.8 - 790 | 279 | 1.08 | 0.609 | 5,500 | 1.50 | 4.15 | 36.0 | 235 |
| 4-Methyl-2-pentanone | 0.77 - 5,630 | 479 | 0.835 | 5 | 22,000 | 2 | 94 | 88.2 | 739 |
| Acenaphthene | 10 - 3,500 | 250 | 2.80 | 330 | 3,900 | 58 | 24,000 | 325 | 1,524 |
| Acenaphthylene[c] | 10 - 3,100 | 249 | 0.402 | 330 | 38,000 | 1,100 | 1,100 | 306 | 1,214 |
| Acetone | 1.5 - 11,300 | 491 | 33.2 | 6 | 22,000 | 2 | 4,890 | 130 | 769 |
| Anthracene | 10 - 2,700 | 250 | 3.60 | 330 | 3,900 | 91 | 8,700 | 270 | 601 |
| Aroclor-1248 | 0.5 - 21,700 | 189 | 0.529 | 0.497 | 5,500 | 7,200 | 7,200 | 134 | 942 |
| Aroclor-1254 | 1 - 21,700 | 189 | 13.8 | 330 | 3,900 | 9.40 | 5,900 | 156 | 618 |
| Aroclor-1260 | 1 - 21,700 | 189 | 3.70 | 330 | 3,900 | 7.20 | 320 | 67.8 | 130 |
| Benzene | 0.1 - 1,500 | 498 | 0.602 | 330 | 77,000 | 0.840 | 14 | 24.6 | 181 |
| Benzo(a)anthracene | 10 - 2,800 | 249 | 7.23 | 330 | 3,900 | 46 | 7,500 | 286 | 606 |
| Benzo(a)pyrene | 10 - 4,500 | 249 | 8.84 | 330 | 77,000 | 48 | 11,000 | 346 | 1,024 |
| Benzo(b)fluoranthene | 10 - 3,200 | 249 | 4.02 | 1,600 | 380,000 | 45 | 7,100 | 430 | 2,475 |
| Benzo(g,h,i)perylene | 10 - 3,000 | 249 | 5.62 | 330 | 77,000 | 84 | 5,200 | 287 | 499 |
| Benzo(k)fluoranthene | 10 - 3,600 | 249 | 2.41 | 330 | 77,000 | 43 | 8,000 | 432 | 2,483 |
| Benzoic Acid | 50 - 32,000 | 234 | 5.13 | 0.888 | 15,000 | 43 | 2,300 | 1,996 | 12,402 |
| bis(2-ethylhexyl)phthalate | 10 - 8,100 | 250 | 20.8 | 0.849 | 5,500 | 35 | 71,000 | 702 | 5,091 |
| Butylbenzylphthalate | 10 - 7,400 | 250 | 13.6 | 0.590 | 5,500 | 35 | 4,900 | 432 | 2,457 |
| Carbon Disulfide | 0.31 - 3,500 | 491 | 0.204 | 330 | 3,900 | 160 | 160 | 60.6 | 510 |
| Carbon Tetrachloride | 0.52 - 1,500 | 496 | 3.43 | 0.497 | 730 | 1 | 6,200 | 38.9 | 332 |
| Chloroform | 0.1 - 1,500 | 492 | 7.11 | 330 | 77,000 | 0.680 | 130 | 25.8 | 182 |
| Chrysene | 10 - 3,100 | 250 | 12.4 | 330 | 77,000 | 40 | 11,000 | 321 | 903 |
| cis-1,2-Dichloroethene | 0.1 - 790 | 280 | 7.50 | 330 | 3,900 | 0.634 | 4,400 | 42.6 | 306 |
| Dibenz(a,h)anthracene[c] | 10 - 2,800 | 249 | 0.803 | 42 | 42 | 170 | 1,700 | 408 | 2,437 |
| Dibenzofuran | 10 - 4,100 | 249 | 0.402 | 340 | 77,000 | 7,000 | 7,000 | 276 | 491 |
| Dicamba | 1.9 - 2 | 5 | 20 | 0.497 | 5,500 | 2.20 | 2.20 | 17.2 | 8.41 |
| Diethylphthalate | 10 - 3,500 | 249 | 0.402 | 330 | 3,900 | 56 | 56 | 481 | 2,439 |
| Di-n-butylphthalate | 10 - 2,300 | 249 | 5.62 | 330 | 3,900 | 37 | 480 | 396 | 2,437 |

**Table 1.4**
**Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[c] |
|---|---|---|---|---|---|---|---|---|---|
| Ethylbenzene | 0.1 - 1,500 | 498 | 1.20 | | | 0.780 | 62 | 24.8 | 181 |
| Fluoranthene | 10 - 2,600 | 250 | 10 | 0.639 | 3,600 | 36 | 18,000 | 331 | 1,184 |
| Fluorene | 10 - 3,800 | 250 | 2 | 330 | 77,000 | 98 | 7,100 | 283 | 522 |
| Fluoroacetamide | 0 | 1 | 100 | 0.497 | 5,500 | 22 | 22 | 22 | 0 |
| Hexachlorobutadiene | 1.4 - 790 | 409 | 0.489 | 0.705 | 5,500 | 16.4 | 310 | 92.6 | 204 |
| Indeno(1,2,3-cd)pyrene | 10 - 2,600 | 249 | 3.61 | 330 | 3,900 | 41 | 3,000 | 409 | 2,441 |
| Methylene Chloride | 0.33 - 1,600 | 498 | 34.5 | 0.746 | 3,600 | 0.830 | 1,500 | 33.0 | 209 |
| Naphthalene | 0.38 - 3,600 | 410 | 5.85 | 33 | 21,700 | 0.920 | 17,000 | 148 | 905 |
| n-Butylbenzene | 1.2 - 790 | 279 | 0.358 | 33 | 380 | 0.620 | 0.620 | 36.0 | 235 |
| N-nitrosodiphenylamine | 10 - 3,100 | 249 | 1.20 | 21 | 3,400 | 870 | 17,000 | 315 | 1,089 |
| Pentachlorophenol | 50 - 13,000 | 249 | 0.402 | 1,600 | 380,000 | 790 | 790 | 1,970 | 12,022 |
| Phenanthrene | 10 - 3,900 | 250 | 11.6 | 330 | 3,900 | 42 | 43,000 | 476 | 2,821 |
| Phenol | 10 - 3,900 | 252 | 18.7 | 330 | 77,000 | 110 | 2,500 | 488 | 2,430 |
| Propylcyclopentane | 0 | 1 | 100 | | | 7.20 | 7.20 | 7.20 | 0 |
| Pyrene | 10 - 15,000 | 250 | 14 | 330 | 3,900 | 46 | 36,000 | 563 | 2,893 |
| Styrene | 0.077 - 1,500 | 491 | 0.407 | 0.545 | 5,500 | 0.0860 | 1.70 | 24.9 | 182 |
| Tetrachloroethene | 0.18 - 1,500 | 496 | 24.8 | 0.838 | 730 | 0.400 | 72,000 | 433 | 4,694 |
| Toluene | 0.085 - 1,500 | 499 | 21.6 | 0.706 | 5,500 | 0.130 | 480 | 38.6 | 186 |
| Trichloroethene | 0.14 - 1,500 | 496 | 10.3 | 0.599 | 1,500 | 0.270 | 1,900 | 26.0 | 144 |
| Xylene[d] | 0.1 - 1,500 | 498 | 5.02 | 0.497 | 5,500 | 1.30 | 400 | 26.6 | 182 |
| **Radionuclides (pCi/g)[e]** | | | | | | | | | |
| Americium-241 | 0 - 1.61 | 396 | N/A | | | -6.16 | 410 | 2.92 | 23.8 |
| Cesium-134 | 0.0325 - 0.0384 | 3 | N/A | | | -0.0374 | -0.0186 | -0.0280 | 0.00940 |
| Cesium-137 | 0.0334 - 0.65 | 82 | N/A | | | -0.0212 | 0.340 | 0.0670 | 0.0637 |
| Gross Alpha | 0.83 - 20.1 | 139 | N/A | | | 1.02 | 4,100 | 72.6 | 369 |
| Gross Beta | 1.75 - 29 | 148 | N/A | | | -260 | 137 | 25.1 | 27.4 |
| Iodine-129 | 0.321 - 0.48 | 7 | N/A | | | -0.648 | 0.125 | -0.153 | 0.297 |
| Nickel-59 | 0.3 - 0.8 | 7 | N/A | | | 0 | 0.420 | 0.209 | 0.197 |
| Plutonium-238 | 0.00286 - 0.216 | 102 | N/A | | | -0.0190 | 19.8 | 0.351 | 2.21 |
| Plutonium-239/240 | 0 - 1.56 | 398 | N/A | | | -0.0182 | 2,450 | 18.3 | 148 |
| Plutonium-241 | 7.1 - 23.5 | 4 | N/A | | | 16.8 | 178 | 98.0 | 69.0 |
| Radium-226 | 0.1 - 0.54 | 63 | N/A | | | -0.176 | 1.44 | 0.664 | 0.335 |
| Radium-228 | 0.118 - 1.3 | 65 | N/A | | | 0 | 2.60 | 1.25 | 0.513 |
| Strontium-89/90 | 0.03 - 1.52 | 85 | N/A | | | -0.630 | 0.830 | 0.193 | 0.214 |
| Tritium | 180 - 420 | 11 | N/A | | | 60 | 510 | 251 | 156 |
| Uranium-233/234 | 0 - 1.02 | 391 | N/A | | | 0.0534 | 14 | 0.994 | 1.49 |
| Uranium-235 | 0 - 0.87 | 391 | N/A | | | -0.144 | 1.70 | 0.0624 | 0.128 |
| Uranium-238 | 0 - 1.5 | 391 | N/A | | | 0.0279 | 64.0 | 1.31 | 4.36 |

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).
[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.
[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.
[d] The value for total xylene is used.
[e] All radionuclide values are considered detects.
N/A = Not applicable.

**Table 1.5**
**Summary of Detected Analytes in Surface Soil**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[b] |
|---|---|---|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | | | | |
| Aluminum | 0.24 - 200 | 151 | 100 | | | 4,780 | 33,000 | 14,613 | 6,893 |
| Ammonia | 0.300 | 9 | 100 | | | 1.09 | 3.33 | 2.07 | 0.845 |
| Antimony[c] | 0.27 - 60 | 130 | 18.5 | 0.270 | 19.3 | 0.300 | 0.880 | 2.64 | 2.75 |
| Arsenic | 0.28 - 10 | 151 | 100 | | | 1 | 11 | 5.21 | 2.14 |
| Barium | 0.039 - 200 | 151 | 100 | | | 34.9 | 280 | 135 | 47.3 |
| Beryllium | 0.031 - 5 | 151 | 68.2 | 0.280 | 1.30 | 0.230 | 1.40 | 0.690 | 0.286 |
| Boron | 0.35 - 1.2 | 76 | 93.4 | 0.350 | 2.70 | 0.670 | 15 | 6.82 | 3.63 |
| Cadmium | 0.03 - 5 | 150 | 44.7 | 0.0300 | 1.30 | 0.0650 | 2.60 | 0.496 | 0.351 |
| Calcium | 1 - 5,000 | 151 | 100 | | | 1,740 | 185,000 | 21,793 | 39,007 |
| Cesium | 200 - 1,000 | 57 | 21.1 | 6.80 | 130 | 1.50 | 7.40 | 30.6 | 28.4 |
| Chromium | 0.053 - 10 | 151 | 100 | | | 2.20 | 80.5 | 16.5 | 10.3 |
| Cobalt | 0.079 - 50 | 151 | 100 | | | 2.20 | 21.6 | 6.61 | 2.42 |
| Copper | 0.045 - 25 | 150 | 100 | | | 2.20 | 49.8 | 14.8 | 6.15 |
| Iron | 0.8 - 100 | 151 | 100 | | | 3,680 | 27,000 | 14,118 | 5,245 |
| Lead | 0.12 - 3 | 151 | 100 | | | 3 | 120 | 34.4 | 20.5 |
| Lithium | 0.17 - 100 | 131 | 92.4 | 2 | 14.1 | 4.40 | 33 | 12.4 | 6.26 |
| Magnesium | 1.6 - 5,000 | 151 | 100 | | | 1,100 | 8,270 | 3,142 | 1,294 |
| Manganese | 0.033 - 15 | 151 | 100 | | | 54 | 1,200 | 284 | 147 |
| Mercury | 0.0012 - 0.2 | 132 | 52.3 | 0.0120 | 0.130 | 0.00560 | 0.250 | 0.0448 | 0.0357 |
| Molybdenum | 0.13 - 200 | 137 | 27.7 | 0.130 | 5.20 | 0.150 | 3 | 1.07 | 1.00 |
| Nickel | 0.19 - 40 | 151 | 96.7 | 8.80 | 9.60 | 4.40 | 101 | 14.6 | 10.3 |
| Nitrate / Nitrite | 0.200 | 9 | 100 | | | 1.60 | 3.83 | 2.63 | 0.748 |
| Potassium | 36 - 5000 | 151 | 100 | | | 690 | 6,200 | 3,101 | 1,229 |
| Selenium | 0.4 - 5 | 150 | 20 | 0.200 | 4.50 | 0.260 | 0.730 | 0.417 | 0.393 |
| Silica | 2.7 - 5.3 | 76 | 100 | | | 175 | 1,100 | 596 | 202 |
| Silicon[c] | 0 - 100 | 37 | 100 | | | 81 | 2,160 | 1,265 | 641 |
| Silver | 0.055 - 10 | 142 | 24.6 | 0.0550 | 5.70 | 0.0810 | 42.8 | 1.30 | 4.22 |
| Sodium | 102 - 5000 | 151 | 27.2 | 46.3 | 594 | 46 | 492 | 97.5 | 67.8 |
| Strontium | 0.0061 - 200 | 137 | 100 | | | 8.90 | 362 | 46.4 | 46.6 |
| Thallium | 0.37 - 10 | 151 | 20.5 | 0.200 | 2.20 | 0.210 | 3.30 | 0.417 | 0.414 |
| Tin | 0.24 - 200 | 137 | 15.3 | 0.860 | 52.3 | 1.30 | 75.8 | 7.95 | 11.3 |
| Titanium | 0.077 - 0.2 | 76 | 100 | | | 33 | 603 | 275 | 129 |
| Uranium | 1.4 - 7.2 | 76 | 5.26 | 1.40 | 7.20 | 1.90 | 8 | 1.89 | 1.41 |
| Vanadium | 0.25 - 50 | 151 | 100 | | | 12.1 | 72 | 31.9 | 12.2 |
| Zinc | 0.2 - 20 | 151 | 100 | | | 15 | 165 | 51.3 | 18.6 |
| **Organics (µg/kg)** | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane[c] | 4.86 - 5.5 | 13 | 7.69 | 0.899 | 1.02 | 1.39 | 1.39 | 0.544 | 0.255 |
| 1,2,3-Trichloropropane[c] | 4.86 - 5.5 | 13 | 7.69 | 0.965 | 1.09 | 1.47 | 1.47 | 0.583 | 0.267 |
| 1,2,4-Trimethylbenzene | 4.86 - 5.5 | 13 | 7.69 | 0.949 | 1.07 | 1.44 | 1.44 | 0.574 | 0.261 |
| 4,4'-DDE | 1.7 - 16 | 40 | 7.50 | 9.50 | 21 | 4 | 5.80 | 8.88 | 1.55 |
| 4,6-Dinitro-2-methylphenol | 130 - 1,600 | 80 | 1.25 | 1,600 | 4,100 | 390 | 390 | 983 | 312 |
| Acenaphthene | 33 - 360 | 85 | 7.06 | 340 | 430 | 45 | 240 | 180 | 29.5 |
| Anthracene | 25 - 360 | 85 | 9.41 | 340 | 430 | 47 | 330 | 184 | 32.3 |
| Aroclor-1248 | 6.2 - 240 | 81 | 1.23 | 0.759 | 0.859 | 840 | 840 | 46.7 | 98.1 |
| Aroclor-1254 | 4.4 - 160 | 81 | 28.4 | 340 | 820 | 6.80 | 3,000 | 118 | 339 |
| Aroclor-1260 | 4.9 - 160 | 81 | 17.3 | 340 | 820 | 6.20 | 240 | 65.6 | 57.5 |
| Benzene[c] | 4.86 - 5.5 | 13 | 7.69 | 340 | 820 | 1.44 | 1.44 | 0.480 | 0.289 |
| Benzo(a)anthracene | 26 - 360 | 85 | 27.1 | 340 | 820 | 39 | 830 | 193 | 114 |
| Benzo(a)pyrene | 43 - 360 | 85 | 16.5 | 340 | 820 | 48 | 750 | 207 | 92.4 |
| Benzo(b)fluoranthene | 31 - 360 | 85 | 16.5 | 1,600 | 4,100 | 40 | 810 | 212 | 97.7 |
| Benzo(g,h,i)perylene | 29 - 360 | 85 | 9.41 | 340 | 820 | 82 | 240 | 199 | 57.8 |
| Benzo(k)fluoranthene | 34 - 360 | 85 | 11.8 | 0.918 | 1.04 | 69 | 740 | 214 | 94.1 |
| Benzoic Acid | 300 - 1,600 | 80 | 33.8 | 340 | 820 | 77 | 1,100 | 772 | 463 |
| bis(2-ethylhexyl)phthalate | 71 - 360 | 85 | 10.6 | 340 | 820 | 56 | 510 | 209 | 83.5 |
| Chlorobenzene[c] | 4.86 - 5.5 | 13 | 7.69 | 340 | 820 | 2.03 | 2.03 | 0.603 | 0.429 |
| Chrysene | 30 - 360 | 85 | 31.8 | 340 | 820 | 39 | 790 | 191 | 112 |
| Dibenz(a,h)anthracene | 26 - 360 | 85 | 4.71 | 9.10 | 47 | 43 | 92 | 198 | 67.6 |
| Dibenzofuran | 38 - 360 | 85 | 2.35 | 9.50 | 21 | 37 | 86 | 201 | 64.5 |
| Dieldrin | 2.9 - 16 | 40 | 5 | 0.987 | 1.12 | 4.30 | 5.80 | 9.84 | 3.41 |
| Di-n-butylphthalate | 22 - 360 | 85 | 1.18 | 340 | 790 | 1,000 | 1,000 | 213 | 106 |
| Endrin | 2 - 16 | 40 | 7.50 | 340 | 820 | 4.50 | 5.10 | 8.87 | 1.51 |
| Ethylbenzene[c] | 4.86 - 5.5 | 13 | 7.69 | 340 | 820 | 1.29 | 1.29 | 0.580 | 0.214 |
| Fluoranthene | 24 - 360 | 84 | 47.6 | 18 | 100 | 45 | 1,900 | 239 | 251 |
| Fluorene | 36 - 360 | 85 | 4.71 | 340 | 820 | 54 | 230 | 201 | 64.9 |
| Indeno(1,2,3-cd)pyrene | 24 - 360 | 85 | 10.6 | 0.765 | 820 | 72 | 220 | 199 | 66.5 |
| Methoxychlor | 0.91 - 80 | 40 | 7.50 | 34 | 730 | 3 | 9.40 | 42.6 | 12.6 |
| Naphthalene[c] | 4.86 - 360 | 98 | 1.02 | 34 | 210 | 0.890 | 0.890 | 177 | 89.4 |
| N-Nitroso-di-n-propylamine | 24 - 360 | 85 | 1.18 | 34 | 730 | 400 | 400 | 206 | 64.2 |
| Phenanthrene | 37 - 360 | 85 | 38.8 | 340 | 820 | 40 | 1,600 | 214 | 202 |
| Pyrene | 41 - 360 | 85 | 60 | 340 | 820 | 43 | 1,800 | 223 | 249 |
| Tetrachloroethene | 4.86 - 5.5 | 13 | 7.69 | 1.18 | 1.33 | 1.73 | 1.73 | 0.704 | 0.309 |
| Toluene[c] | 4.86 - 5.5 | 13 | 7.69 | 1.22 | 1.38 | 2.26 | 2.26 | 0.766 | 0.450 |
| **Radionuclides (pCi/g)[d]** | | | | | | | | | |

**Table 1.5**
**Summary of Detected Analytes in Surface Soil**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[b] |
|---|---|---|---|---|---|---|---|---|---|
| Americium-241 | 0 - 0.261 | 279 | N/A | | | 0 | 15.6 | 1.86 | 2.44 |
| Cesium-134 | 0.0271 - 0.1 | 28 | N/A | | | -0.0101 | 0.100 | 0.0169 | 0.0316 |
| Cesium-137 | 0.031 - 0.21 | 28 | N/A | | | 0.170 | 2.01 | 0.982 | 0.497 |
| Gross Alpha | 2.2 - 20 | 39 | N/A | | | -0.980 | 320 | 38.5 | 58.3 |
| Gross Beta | 1 - 20 | 46 | N/A | | | 19 | 51.1 | 33.9 | 5.88 |
| Plutonium-238 | 0.0284 - 0.211 | 9 | N/A | | | 0.102 | 1.53 | 0.447 | 0.454 |
| Plutonium-239/240 | 0 - 0.288 | 307 | N/A | | | -0.00292 | 49 | 9.44 | 12.1 |
| Radium-226 | 0.157 - 0.5 | 33 | N/A | | | 0.590 | 1.46 | 1.05 | 0.207 |
| Radium-228 | 0.11 - 0.69 | 13 | N/A | | | 1.35 | 3.50 | 2.16 | 0.602 |
| Strontium-89/90 | 0.0734 - 0.4 | 8 | N/A | | | 0.0600 | 1.24 | 0.473 | 0.347 |
| Uranium-233/234 | 0 - 0.674 | 193 | N/A | | | 0.119 | 7.96 | 1.12 | 0.799 |
| Uranium-235 | 0 - 0.448 | 192 | N/A | | | -0.0431 | 0.680 | 0.0827 | 0.0922 |
| Uranium-238 | 0 - 0.438 | 193 | N/A | | | 0.351 | 3.78 | 1.12 | 0.454 |

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

**Table 1.6**
**Summary of Detected Analytes in Subsurface Soil**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[b] |
|---|---|---|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | | | | |
| Aluminum | 1.2 - 40 | 309 | 100 | | | 1,050 | 54,000 | 13,189 | 7,737 |
| Ammonia | 0.300 | 62 | 22.6 | 0.321 | 0.379 | 0.353 | 1.44 | 0.289 | 0.269 |
| Antimony | 0.27 - 12 | 303 | 15.2 | 0.270 | 32.2 | 0.300 | 350 | 4.60 | 25.5 |
| Arsenic | 0.23 - 2 | 309 | 98.1 | 0.400 | 6.80 | 0.820 | 25.9 | 5.21 | 3.13 |
| Barium | 0.039 - 40 | 309 | 99.7 | 56.3 | 56.3 | 9.20 | 838 | 115 | 99.4 |
| Beryllium | 0.03 - 1 | 309 | 80.3 | 0.0310 | 0.982 | 0.0650 | 2.30 | 0.697 | 0.421 |
| Boron | 0.34 - 1.2 | 162 | 78.4 | 0.350 | 1.50 | 0.600 | 15 | 4.18 | 3.85 |
| Cadmium | 0.047 - 1.96 | 286 | 35.0 | 0.0470 | 2.90 | 0.0520 | 58.7 | 0.866 | 3.87 |
| Calcium | 1.4 - 2,000 | 309 | 100 | | | 1,240 | 260,000 | 40,641 | 54,538 |
| Cesium | 89.5 - 200 | 142 | 64.8 | 7.10 | 120 | 0.640 | 21 | 8.70 | 14.1 |
| Chromium | 0.053 - 2 | 309 | 100 | | | 2.90 | 4,600 | 32.7 | 261 |
| Cobalt | 0.078 - 10 | 309 | 96.1 | 0.710 | 7.80 | 0.720 | 24 | 5.44 | 3.32 |
| Copper | 0.043 - 5 | 309 | 99.0 | 3.60 | 10.6 | 2.10 | 180 | 13.9 | 15.1 |
| Iron | 0.57 - 20 | 309 | 100 | | | 2,250 | 152,000 | 13,133 | 10,298 |
| Lead | 0.19 - 19.63 | 309 | 99.7 | 19.6 | 19.6 | 1.50 | 8,500 | 42.9 | 484 |
| Lithium | 0.17 - 20 | 304 | 93.1 | 1 | 13.9 | 1.10 | 44 | 11.0 | 6.70 |
| Magnesium | 1.6 - 2,000 | 309 | 99.7 | 3,080 | 3,080 | 364 | 12,200 | 3,163 | 1,624 |
| Manganese | 0.032 - 3 | 309 | 100 | | | 15.8 | 1,300 | 193 | 181 |
| Mercury | 0.0012 - 0.2 | 308 | 63.6 | 0.00140 | 0.240 | 0.00150 | 3.40 | 0.0971 | 0.345 |
| Molybdenum | 0.13 - 40 | 304 | 50 | 0.130 | 9.82 | 0.140 | 1,970 | 7.97 | 113 |
| Nickel | 0.19 - 8 | 309 | 98.7 | 0.690 | 8 | 2.70 | 1,330 | 24.1 | 80.6 |
| Nitrate / Nitrite | 0.2 - 0.21 | 66 | 66.7 | 0.214 | 9.73 | 0.238 | 43.6 | 1.92 | 6.23 |
| Phosphorus | N/A | 1 | 100 | | | 160 | 160 | 160 | 0 |
| Potassium | 34 - 2,000 | 308 | 97.1 | 259 | 658 | 300 | 13,000 | 1,929 | 1,590 |
| Selenium | 0.3 - 49.08 | 309 | 4.53 | 0.200 | 49.1 | 0.230 | 1.50 | 0.380 | 1.39 |
| Silica | 2.6 - 5.9 | 162 | 100 | | | 174 | 1,200 | 600 | 226 |
| Silicon | 0 - 200 | 75 | 96 | 10.9 | 16.9 | 6 | 2,210 | 361 | 440 |
| Silver | 0.055 - 2.94 | 308 | 19.8 | 0.0550 | 5 | 0.0640 | 219 | 2.17 | 13.6 |
| Sodium | 2.4 - 2,000 | 308 | 51.6 | 39.4 | 472 | 36.9 | 3,700 | 217 | 430 |
| Strontium | 0.0061 - 400 | 309 | 99.0 | 21.8 | 60.9 | 6.20 | 459 | 61.4 | 60.0 |
| Sulfide | 10 - 16.3 | 66 | 10.6 | 10.5 | 22.6 | 12 | 83.5 | 8.08 | 9.74 |
| Thallium | 0.28 - 29.45 | 309 | 35.0 | 0.200 | 29.4 | 0.220 | 10.8 | 0.640 | 1.09 |
| Tin | 0.39 - 40 | 303 | 24.8 | 0.700 | 73.2 | 0.570 | 110 | 7.02 | 11.7 |
| Titanium | 0.083 - 0.24 | 163 | 100 | | | 38.7 | 650 | 225 | 149 |
| Total Petroleum Hydrocarbons | 1 - 30 | 27 | 63.0 | 5.86 | 37 | 6.21 | 249 | 64.5 | 76.3 |
| Uranium | 1.3 - 1.9 | 162 | 29.0 | 1.30 | 1.70 | 1.70 | 19 | 1.80 | 2.21 |
| Vanadium | 0.24 - 10 | 309 | 99.7 | 21 | 21 | 4.60 | 72 | 28.9 | 14.2 |
| Zinc | 0.2 - 4 | 309 | 99.7 | 20 | 20 | 5.30 | 550 | 34.2 | 38.6 |
| **Organics (µg/kg)** | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.1 - 1,500 | 495 | 2.22 | 0.778 | 5,500 | 1 | 300 | 24.8 | 181 |
| 1,1,2,2-Tetrachloroethane | 0.62 - 1,500 | 485 | 0.412 | 0.522 | 5,500 | 22 | 72 | 25.1 | 183 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.12 - 2,100 | 284 | 0.352 | 0.888 | 5,500 | 0.800 | 0.800 | 35.9 | 233 |
| 1,1-Dichloroethene | 0.31 - 1,500 | 490 | 0.408 | 0.632 | 5,500 | 1 | 7 | 25.0 | 182 |
| 1,2,3-Trichlorobenzene | 0.4 - 840 | 279 | 1.79 | 0.637 | 5,500 | 0.630 | 3.70 | 36.0 | 235 |
| 1,2,4-Trichlorobenzene | 0.26 - 790 | 409 | 0.733 | 0.753 | 3,600 | 0.510 | 14 | 92.0 | 203 |
| 1,2,4-Trimethylbenzene | 0.12 - 790 | 279 | 4.66 | 0.586 | 5,500 | 0.120 | 11.8 | 36.1 | 235 |
| 1,2-Dichlorobenzene | 0.099 - 790 | 415 | 0.482 | 0.497 | 3,600 | 0.190 | 0.640 | 90.6 | 202 |
| 1,2-Dichloroethene | 5 - 1,500 | 155 | 2.58 | 5 | 1,500 | 2 | 110 | 8.83 | 60.6 |
| 1,3,5-Trimethylbenzene | 0.52 - 790 | 279 | 1.79 | 0.530 | 5,500 | 1.10 | 4.70 | 36.0 | 235 |
| 1,3-Dichlorobenzene | 0.41 - 790 | 410 | 0.244 | 0.500 | 3,600 | 0.720 | 0.720 | 91.7 | 203 |
| 1,4-Dichlorobenzene | 0.62 - 790 | 410 | 0.732 | 0.924 | 3,600 | 0.870 | 84 | 90.7 | 203 |
| 2-Butanone | 1.7 - 11,300 | 466 | 6.01 | 5 | 15,000 | 1.70 | 8,100 | 123 | 765 |
| 2-Chlorophenol | 10 - 3,800 | 249 | 0.402 | 330 | 77,000 | 46 | 46 | 402 | 2,436 |
| 2-Hexanoneb | 0.6 - 5,630 | 470 | 0.213 | 5 | 22,000 | 0.800 | 0.800 | 89.7 | 746 |
| 2-Methylnaphthalene | 10 - 3,600 | 249 | 2.01 | 330 | 3,900 | 57 | 83,000 | 676 | 5,491 |
| 4-Chloro-3-methylphenol | 10 - 3,800 | 249 | 0.402 | 330 | 150,000 | 37 | 37 | 660 | 4,754 |
| 4-Isopropyltoluene[c] | 0.8 - 790 | 279 | 1.08 | 0.609 | 5,500 | 1.50 | 4.15 | 36.0 | 235 |
| 4-Methyl-2-pentanone | 0.77 - 5,630 | 478 | 0.837 | 5 | 22,000 | 2 | 94 | 88.4 | 740 |
| Acenaphthene | 10 - 3,500 | 250 | 2.80 | 330 | 3,900 | 58 | 24,000 | 325 | 1,524 |
| Acenaphthylene[c] | 10 - 3,100 | 249 | 0.402 | 330 | 38,000 | 1,100 | 1,100 | 306 | 1,214 |
| Acetone | 1.5 - 11,300 | 490 | 33.1 | 6 | 22,000 | 2 | 4,890 | 131 | 770 |
| Anthracene | 10 - 2,700 | 250 | 3.60 | 330 | 3,900 | 91 | 8,700 | 270 | 601 |
| Aroclor-1248 | 0.5 - 21,700 | 189 | 0.529 | 0.497 | 5,500 | 7,200 | 7,200 | 134 | 942 |
| Aroclor-1254 | 1 - 21,700 | 189 | 13.8 | 330 | 3,900 | 9.40 | 5,900 | 156 | 618 |
| Aroclor-1260 | 1 - 21,700 | 189 | 3.70 | 330 | 3,900 | 7.20 | 320 | 67.8 | 130 |
| Benzene | 0.1 - 1,500 | 497 | 0.604 | 330 | 77,000 | 0.840 | 14 | 24.6 | 181 |
| Benzo(a)anthracene | 10 - 2,800 | 249 | 7.23 | 330 | 3,900 | 46 | 7,500 | 286 | 606 |
| Benzo(a)pyrene | 10 - 4,500 | 249 | 8.84 | 330 | 77,000 | 48 | 11,000 | 346 | 1,024 |
| Benzo(b)fluoranthene | 10 - 3,200 | 249 | 4.02 | 1,600 | 380,000 | 45 | 7,100 | 430 | 2,475 |
| Benzo(g,h,i)perylene | 10 - 3,000 | 249 | 5.62 | 330 | 77,000 | 84 | 5,200 | 287 | 499 |
| Benzo(k)fluoranthene | 10 - 3,600 | 249 | 2.41 | 330 | 77,000 | 43 | 8,000 | 432 | 2,483 |
| Benzoic Acid | 50 - 32,000 | 234 | 5.13 | 0.888 | 15,000 | 43 | 2,300 | 1,996 | 12,402 |
| bis(2-ethylhexyl)phthalate | 10 - 8,100 | 250 | 20.8 | 0.849 | 5,500 | 35 | 71,000 | 702 | 5,091 |
| Butylbenzylphthalate | 10 - 7,400 | 250 | 13.6 | 0.590 | 5,500 | 35 | 4,900 | 432 | 2,457 |
| Carbon Disulfide | 0.31 - 3,500 | 490 | 0.204 | 330 | 3,900 | 160 | 160 | 60.7 | 510 |
| Carbon Tetrachloride | 0.52 - 1,500 | 495 | 3.43 | 0.497 | 730 | 1 | 6,200 | 38.9 | 332 |
| Chloroform | 0.1 - 1,500 | 491 | 7.13 | 330 | 77,000 | 0.680 | 130 | 25.8 | 182 |
| Chrysene | 10 - 3,100 | 250 | 12.4 | 330 | 77,000 | 40 | 11,000 | 321 | 903 |
| cis-1,2-Dichloroethene | 0.1 - 790 | 280 | 7.50 | 330 | 3,900 | 0.634 | 4,400 | 42.6 | 306 |
| Dibenz(a,h)anthracene[c] | 10 - 2,800 | 249 | 0.803 | 42 | 42 | 170 | 1,700 | 408 | 2,437 |
| Dibenzofuran | 10 - 4,100 | 249 | 0.402 | 340 | 77,000 | 7,000 | 7,000 | 276 | 491 |
| Dicamba | 1.9 - 2 | 5 | 20 | 0.497 | 5,500 | 2.20 | 2.20 | 17.2 | 8.41 |
| Diethylphthalate | 10 - 3,500 | 249 | 0.402 | 330 | 3,900 | 56 | 56 | 481 | 2,439 |
| Di-n-butylphthalate | 10 - 2,300 | 249 | 5.62 | 330 | 3,900 | 37 | 480 | 396 | 2,437 |
| Ethylbenzene | 0.1 - 1,500 | 497 | 1.21 | | | 0.780 | 62 | 24.8 | 181 |
| Fluoranthene | 10 - 2,600 | 250 | 10 | 0.639 | 3,600 | 36 | 18,000 | 331 | 1,184 |
| Fluorene | 10 - 3,800 | 250 | 2 | 330 | 77,000 | 98 | 7,100 | 283 | 522 |
| Fluoroacetamide | N/A | 1 | 100 | 0.497 | 5,500 | 22 | 22 | 22 | 0 |
| Hexachlorobutadiene | 1.4 - 790 | 409 | 0.489 | 0.705 | 5,500 | 16.4 | 310 | 92.6 | 204 |
| Indeno(1,2,3-cd)pyrene | 10 - 2,600 | 249 | 3.61 | 330 | 3,900 | 41 | 3,000 | 409 | 2,441 |
| Methylene Chloride | 0.33 - 1,600 | 497 | 34.4 | 0.746 | 3,600 | 0.830 | 1,500 | 33.1 | 209 |

**Table 1.6**
**Summary of Detected Analytes in Subsurface Soil**

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Reported Non-Detect Concentration[a] | Maximum Reported Non-Detect Concentration[a] | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration[b] | Standard Deviation[b] |
|---|---|---|---|---|---|---|---|---|---|
| Naphthalene | 0.38 - 3,600 | 410 | 5.85 | 33 | 21,700 | 0.920 | 17,000 | 148 | 905 |
| n-Butylbenzene | 1.2 - 790 | 279 | 0.358 | 33 | 380 | 0.620 | 0.620 | 36.0 | 235 |
| N-nitrosodiphenylamine | 10 - 3,100 | 249 | 1.20 | 21 | 3,400 | 870 | 17,000 | 315 | 1,089 |
| Pentachlorophenol | 50 - 13,000 | 249 | 0.402 | 1,600 | 380,000 | 790 | 790 | 1,970 | 12,022 |
| Phenanthrene | 10 - 3,900 | 250 | 11.6 | 330 | 3,900 | 42 | 43,000 | 476 | 2,821 |
| Phenol | 10 - 3,900 | 252 | 18.7 | 330 | 77,000 | 110 | 2,500 | 488 | 2,430 |
| Propylcyclopentane | 0 | 1 | 100 | | | 7.20 | 7.20 | 7.20 | 0 |
| Pyrene | 10 - 15,000 | 250 | 14 | 330 | 3,900 | 46 | 36,000 | 563 | 2,893 |
| Styrene | 0.077 - 1,500 | 490 | 0.408 | 0.545 | 5,500 | 0.0860 | 1.70 | 25.0 | 182 |
| Tetrachloroethene | 0.18 - 1,500 | 495 | 24.8 | 0.838 | 730 | 0.400 | 72,000 | 434 | 4,699 |
| Toluene | 0.085 - 1,500 | 498 | 21.5 | 0.706 | 5,500 | 0.130 | 480 | 38.7 | 187 |
| Trichloroethene | 0.14 - 1,500 | 495 | 10.3 | 0.599 | 1,500 | 0.270 | 1,900 | 26.0 | 144 |
| Xylene[d] | 0.1 - 1,500 | 497 | 5.03 | 0.497 | 5,500 | 1.30 | 400 | 26.6 | 182 |
| **Radionuclides (pCi/g)[e]** | | | | | | | | | |
| Americium-241 | 0 - 1.61 | 393 | N/A | | | -6.16 | 410 | 2.94 | 23.9 |
| Cesium-134 | 0.0325 - 0.0384 | 3 | N/A | | | -0.0374 | -0.0186 | -0.0280 | 0.00940 |
| Cesium-137 | 0.0334 - 0.65 | 82 | N/A | | | -0.0212 | 0.340 | 0.0670 | 0.0637 |
| Gross Alpha | 0.83 - 20.1 | 136 | N/A | | | 1.02 | 4,100 | 73.7 | 373 |
| Gross Beta | 1.75 - 29 | 145 | N/A | | | -260 | 137 | 25.4 | 27.6 |
| Iodine-129 | 0.321 - 0.48 | 7 | N/A | | | -0.648 | 0.125 | -0.153 | 0.297 |
| Nickel-59 | 0.3 - 0.8 | 7 | N/A | | | 0 | 0.420 | 0.209 | 0.197 |
| Plutonium-238 | 0.00286 - 0.216 | 102 | N/A | | | -0.0190 | 19.8 | 0.351 | 2.21 |
| Plutonium-239/240 | 0 - 1.56 | 395 | N/A | | | -0.0182 | 2,450 | 18.5 | 149 |
| Plutonium-241 | 7.1 - 23.5 | 4 | N/A | | | 16.8 | 178 | 98.0 | 69.0 |
| Radium-226 | 0.1 - 0.54 | 63 | N/A | | | -0.176 | 1.44 | 0.664 | 0.335 |
| Radium-228 | 0.118 - 1.3 | 65 | N/A | | | 0 | 2.60 | 1.25 | 0.513 |
| Strontium-89/90 | 0.03 - 1.52 | 85 | N/A | | | -0.630 | 0.830 | 0.193 | 0.214 |
| Tritium | 180 - 420 | 11 | N/A | | | 60 | 510 | 251 | 156 |
| Uranium-233/234 | 0 - 1.02 | 388 | N/A | | | 0.0534 | 14 | 0.995 | 1.50 |
| Uranium-235 | 0 - 0.87 | 388 | N/A | | | -0.144 | 1.70 | 0.0624 | 0.128 |
| Uranium-238 | 0 - 1.5 | 388 | N/A | | | 0.0279 | 64.0 | 1.32 | 4.38 |

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] The value for total xylene is used.

[e] All radionuclide values are considered detects.
N/A = Not applicable.

**Table 2.1**
**Essential Nutrient Screen for Surface Soil/Surface Sediment**

| Analyte | MDC (mg/kg) | Estimated Maximum Daily Intake[a] (mg/day) | RDA/RDI/AI[b] (mg/day) | UL[b] (mg/day) | Retain for PRG Screen? |
|---|---|---|---|---|---|
| Calcium | 185,000 | 18.5 | 500-1,200 | 2,500 | No |
| Magnesium | 8,270 | 0.827 | 80-420 | 65-110 | No |
| Potassium | 6,200 | 0.62 | 2,000-3,500 | N/A | No |
| Sodium | 492 | 0.0492 | 500-2,400 | N/A | No |

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.
[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.
N/A = Not available.

**Table 2.2**
**PRG Screen for Surface Soil/Surface Sediment**

| Analyte | PRG[a] | MDC | MDC Exceeds PRG? | UCL[b] | UCL Exceeds PRG? | Retain for Detection Frequency Screen? |
|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | |
| Aluminum | 24,774 | 33,000 | Yes | 15,272 | No | No |
| Ammonia | 910,997 | 3.33 | No | -- | -- | No |
| Antimony | 44.4 | 0.880 | No | -- | -- | No |
| **Arsenic** | **2.41** | **11** | **Yes** | **5.50** | **Yes** | **Yes** |
| Barium | 2,872 | 280 | No | -- | -- | No |
| Beryllium | 100 | 1.40 | No | -- | -- | No |
| Boron | 9,477 | 15 | No | -- | -- | No |
| Cadmium | 91.4 | 2.60 | No | -- | -- | No |
| Cesium | N/A | 7.40 | UT | -- | -- | UT |
| Chromium[c] | 28.4 | 80.5 | Yes | 19.7 | No | No |
| Cobalt | 122 | 21.6 | No | -- | -- | No |
| Copper | 4,443 | 49.8 | No | -- | -- | No |
| Iron | 33,326 | 27,000 | No | -- | -- | No |
| Lead | 1,000 | 120 | No | -- | -- | No |
| Lithium | 2,222 | 33 | No | -- | -- | No |
| Manganese | 419 | 1,200 | Yes | 302 | No | No |
| Mercury | 32.9 | 0.250 | No | -- | -- | No |
| Molybdenum | 555 | 6.10 | No | -- | -- | No |
| Nickel | 2,222 | 101 | No | -- | -- | No |
| Nitrate / Nitrite[d] | 177,739 | 3.83 | No | -- | -- | No |
| Selenium | 555 | 0.880 | No | -- | -- | No |
| Silica | N/A | 1,100 | UT | -- | -- | UT |
| Silicon | N/A | 2,160 | UT | -- | -- | UT |
| Silver | 555 | 42.8 | No | -- | -- | No |
| Strontium | 66,652 | 362 | No | -- | -- | No |
| Thallium | 7.78 | 3.30 | No | -- | -- | No |
| Tin | 66,652 | 77.2 | No | -- | -- | No |
| Titanium | 169,568 | 603 | No | -- | -- | No |
| Uranium | 333 | 8 | No | -- | -- | No |
| Vanadium | 111 | 72 | No | -- | -- | No |
| Zinc | 33,326 | 216 | No | -- | -- | No |
| **Organics (µg/kg)** | | | | | | |
| 1,1,2,2-Tetrachloroethane | 10,483 | 1.39 | No | -- | -- | No |
| 1,2,3-Trichloropropane | 2,079 | 1.47 | No | -- | -- | No |
| 1,2,4-Trimethylbenzene | 132,620 | 1.44 | No | -- | -- | No |
| 2-Butanone | 4.64E+07 | 19 | No | -- | -- | No |
| 4,4'-DDE | 10,961 | 5.80 | No | -- | -- | No |
| 4,6-Dinitro-2-methylphenol | 8,014 | 390 | No | -- | -- | No |
| Acenaphthene | 4.44E+06 | 240 | No | -- | -- | No |
| Acetone | 1.00E+08 | 71 | No | -- | -- | No |
| Aldrin | 176 | 0 | No | -- | -- | No |
| alpha-Chlordane | 10,261 | 0 | No | -- | -- | No |
| Anthracene | 2.22E+07 | 330 | No | -- | -- | No |
| Aroclor-1248 | 1,349 | 840 | No | -- | -- | No |
| Aroclor-1254 | 1,349 | 3,000 | Yes | 327 | No | No |
| Aroclor-1260 | 1,349 | 240 | No | -- | -- | No |
| Benzene | 23,563 | 1.44 | No | -- | -- | No |
| Benzo(a)anthracene | 3,793 | 830 | No | -- | -- | No |
| Benzo(a)pyrene | 379 | 750 | Yes | 226 | No | No |
| Benzo(b)fluoranthene | 3,793 | 810 | No | -- | -- | No |
| Benzo(g,h,i)perylene | N/A | 240 | UT | -- | -- | UT |
| Benzo(k)fluoranthene | 37,927 | 740 | No | -- | -- | No |
| Benzoic Acid | 3.21E+08 | 1,100 | No | -- | -- | No |
| beta-BHC | 1,995 | 0 | No | -- | -- | No |
| bis(2-ethylhexyl)phthalate | 213,750 | 1,400 | No | -- | -- | No |
| Chlorobenzene | 666,523 | 2.03 | No | -- | -- | No |
| Chrysene | 379,269 | 790 | No | -- | -- | No |
| delta-BHC | 570 | 0 | No | -- | -- | No |

**Table 2.2**
**PRG Screen for Surface Soil/Surface Sediment**

| Analyte | PRG[a] | MDC | MDC Exceeds PRG? | UCL[b] | UCL Exceeds PRG? | Retain for Detection Frequency Screen? |
|---|---|---|---|---|---|---|
| Dibenz(a,h)anthracene | 379 | 92 | No | -- | -- | No |
| Dibenzofuran | 222,174 | 86 | No | -- | -- | No |
| Dieldrin | 187 | 5.80 | No | -- | -- | No |
| Di-n-butylphthalate | 8.01E+06 | 1,000 | No | -- | -- | No |
| Di-n-octylphthalate | 3.21E+06 | 210 | No | -- | -- | No |
| Endosulfan I | 480,861 | 0 | No | -- | -- | No |
| Endrin | 24,043 | 5.10 | No | -- | -- | No |
| Ethylbenzene | 5.39E+06 | 1.29 | No | -- | -- | No |
| Fluoranthene | 2.96E+06 | 1,900 | No | -- | -- | No |
| Fluorene | 3.21E+06 | 230 | No | -- | -- | No |
| gamma-Chlordane | 10,261 | 0 | No | -- | -- | No |
| Heptachlor | 665 | 0 | No | -- | -- | No |
| Heptachlor epoxide | 329 | 0 | No | -- | -- | No |
| Indeno(1,2,3-cd)pyrene | 3,793 | 220 | No | -- | -- | No |
| Methoxychlor | 400,718 | 9.40 | No | -- | -- | No |
| Methylene Chloride | 271,792 | 14 | No | -- | -- | No |
| Naphthalene | 1.40E+06 | 0.890 | No | -- | -- | No |
| N-Nitroso-di-n-propylamine | 429 | 400 | No | -- | -- | No |
| Phenanthrene | N/A | 1,600 | UT | -- | -- | UT |
| Pyrene | 2.22E+06 | 1,800 | No | -- | -- | No |
| Tetrachloroethene | 6,705 | 1.73 | No | -- | -- | No |
| Toluene | 3.09E+06 | 2.26 | No | -- | -- | No |
| **Radionuclides (pCi/g)** | | | | | | |
| Americium-241 | 7.69 | 15.6 | Yes | 2.43 | No | No |
| Cesium-134 | 0.0800 | 0.200 | Yes | 0.076 | No | No |
| **Cesium-137** | **0.221** | **2.01** | **Yes** | **1.71** | **Yes** | **Yes** |
| Gross Alpha | N/A | 320 | UT | -- | -- | No |
| Gross Beta | N/A | 64 | UT | -- | -- | No |
| Plutonium-238 | 5.97 | 1.53 | No | -- | -- | No |
| **Plutonium-239/240** | **9.80** | **49** | **Yes** | **12.1** | **Yes** | **Yes** |
| Radium-226 | 2.69 | 2.19 | No | -- | -- | No |
| **Radium-228** | **0.111** | **3.50** | **Yes** | **2.38** | **Yes** | **Yes** |
| Strontium-89/90 | 13.2 | 1.46 | No | -- | -- | No |
| Uranium-233/234 | 25.3 | 7.96 | No | -- | -- | No |
| Uranium-235 | 1.05 | 0.680 | No | -- | -- | No |
| Uranium-238 | 29.3 | 3.78 | No | -- | -- | No |

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[c] The PRG for chromium (VI) is used.

[d] The PRG for nitrate is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

**Bold = Analyte retained for further consideration in the next COC selection step.**

**Table 2.3**
**Statistical Distributions and Comparison to Background for Human Health PCOCs in WBEU[a]**

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | Background Data Set | | | WBEU Data Set | | | | | |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Test | 1-p | Statistically Greater than Background? |
| **Surface Soil/Surface Sediment** | | | | | | | | | |
| **Arsenic** | **73** | **GAMMA** | **91.8** | **160** | **GAMMA** | **100** | **WRS** | **2.36E-08** | **Yes** |
| Cesium-137 | 105 | NON-PARAMETRIC | N/A | 37 | NON-PARAMETRIC | N/A | N/A | 0.206 | No |
| **Plutonium-239/240** | **94** | **NON-PARAMETRIC** | **N/A** | **319** | **NON-PARAMETRIC** | **N/A** | **N/A** | **0** | **Yes** |
| **Radium-228** | **40** | **GAMMA** | **N/A** | **17** | **NORMAL** | **N/A** | **N/A** | **0.00727** | **Yes** |
| **Subsurface Soil/Subsurface Sediment** | | | | | | | | | |
| Radium-228 | 31 | GAMMA | N/A | 65 | NORMAL | N/A | N/A | 0.973 | No |

[a] EU data used for background comparisons do not include data from background locations.
N/A = Not applicable; all radionuclide values are considered detect.
**Bold = Analyte retained for further consideration in the next COC selection step.**
WRS = Wilcoxon Rank Sum.

**Table 2.4**
**Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment**

| Analyte | MDC (mg/kg) | Estimated Maximum Daily Intake[a] (mg/day) | RDA/RDI/AI[b] (mg/day) | UL[b] (mg/day) | Retain for PRG Screen? |
|---|---|---|---|---|---|
| Calcium | 260,000 | 26.0 | 500-1,200 | 2,500 | No |
| Magnesium | 12,200 | 1.22 | 80-420 | 65-110 | No |
| Potassium | 13,000 | 1.30 | 2,000-3,500 | N/A | No |
| Sodium | 3,700 | 0.370 | 500-2,400 | N/A | No |

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

**Table 2.5**
**PRG Screen for Subsurface Soil/Subsurface Sediment**

| Analyte | PRG[a] | MDC | MDC Exceeds PRG? | UCL[b] | UCL Exceeds PRG? | Retain for Detection Frequency Screen? |
|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | |
| Aluminum | 284,902 | 54,000 | No | -- | -- | No |
| Ammonia | 1.05E+07 | 1.44 | No | -- | -- | No |
| Antimony | 511 | 350 | No | -- | -- | No |
| Arsenic | 27.7 | 25.9 | No | -- | -- | No |
| Barium | 33,033 | 838 | No | -- | -- | No |
| Beryllium | 1,151 | 2.30 | No | -- | -- | No |
| Boron | 108,980 | 15 | No | -- | -- | No |
| Cadmium | 1,051 | 58.7 | No | -- | -- | No |
| Cesium | N/A | 21 | UT | -- | -- | UT |
| Chromium[c] | 327 | 4,600 | Yes | 97.2 | No | No |
| Cobalt | 1,401 | 24 | No | -- | -- | No |
| Copper | 51,100 | 180 | No | -- | -- | No |
| Iron | 383,250 | 152,000 | No | -- | -- | No |
| Lead | 1,000 | 8,500 | Yes | 163 | No | No |
| Lithium | 25,550 | 44 | No | -- | -- | No |
| Manganese | 4,815 | 1,300 | No | -- | -- | No |
| Mercury | 379 | 3.40 | No | -- | -- | No |
| Molybdenum | 6,388 | 1,970 | No | -- | -- | No |
| Nickel | 25,550 | 1,330 | No | -- | -- | No |
| Nitrate / Nitrite[d] | 2.04E+06 | 43.6 | No | -- | -- | No |
| Phosphorus | N/A | 160 | UT | -- | -- | UT |
| Selenium | 6,388 | 1.50 | No | -- | -- | No |
| Silica | N/A | 1,200 | UT | -- | -- | UT |
| Silicon | N/A | 2,210 | UT | -- | -- | UT |
| Silver | 6,388 | 219 | No | -- | -- | No |
| Strontium | 766,500 | 459 | No | -- | -- | No |
| Thallium | 89.4 | 10.8 | No | -- | -- | No |
| Tin | 766,500 | 110 | No | -- | -- | No |
| Titanium | 1.95E+06 | 650 | No | -- | -- | No |
| Total Petroleum Hydrocarbons | N/A | 249 | UT | -- | -- | UT |
| Uranium | 3,833 | 19 | No | -- | -- | No |
| Vanadium | 1,278 | 72 | No | -- | -- | No |
| Zinc | 383,250 | 550 | No | -- | -- | No |
| **Organics (µg/kg)** | | | | | | |
| 1,1,1-Trichloroethane | 1.06E+08 | 300 | No | -- | -- | No |
| 1,1,2,2-Tetrachloroethane | 120,551 | 72 | No | -- | -- | No |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 2.74E+10 | 0.800 | No | -- | -- | No |
| 1,1-Dichloroethene | 199,706 | 7 | No | -- | -- | No |
| 1,2,3-Trichlorobenzene | N/A | 3.70 | UT | -- | -- | UT |
| 1,2,4-Trichlorobenzene | 1.74E+06 | 14 | No | -- | -- | No |
| 1,2,4-Trimethylbenzene | 1.53E+06 | 11.8 | No | -- | -- | No |
| 1,2-Dichlorobenzene | 3.32E+07 | 0.640 | No | -- | -- | No |
| 1,2-Dichloroethene | 1.15E+07 | 110 | No | -- | -- | No |
| 1,3,5-Trimethylbenzene | 1.31E+06 | 4.70 | No | -- | -- | No |
| 1,3-Dichlorobenzene | 3.83E+07 | 0.720 | No | -- | -- | No |
| 1,4-Dichlorobenzene | 1.05E+06 | 84 | No | -- | -- | No |
| 2-Butanone | 5.33E+08 | 8,100 | No | -- | -- | No |
| 2-Chlorophenol | 6.39E+06 | 46 | No | -- | -- | No |
| 2-Hexanone | N/A | 0.800 | UT | -- | -- | UT |
| 2-Methylnaphthalene | 3.69E+06 | 83,000 | No | -- | -- | No |
| 4-Chloro-3-methylphenol | N/A | 37 | UT | -- | -- | UT |
| 4-Isopropyltoluene | N/A | 4.15 | UT | -- | -- | UT |
| 4-Methyl-2-pentanone | 9.57E+08 | 94 | No | -- | -- | No |
| Acenaphthene | 5.10E+07 | 24,000 | No | -- | -- | No |
| Acenaphthylene | N/A | 1,100 | UT | -- | -- | UT |
| Acetone | 1.15E+09 | 4,890 | No | -- | -- | No |
| Anthracene | 2.55E+08 | 8,700 | No | -- | -- | No |
| Aroclor-1248 | 15,514 | 7,200 | No | -- | -- | No |
| Aroclor-1254 | 15,514 | 5,900 | No | -- | -- | No |
| Aroclor-1260 | 15,514 | 320 | No | -- | -- | No |
| Benzene | 270,977 | 14 | No | -- | -- | No |
| Benzo(a)anthracene | 43,616 | 7,500 | No | -- | -- | No |
| Benzo(a)pyrene | 4,357 | 11,000 | Yes | 628 | No | No |
| Benzo(b)fluoranthene | 43,616 | 7,100 | No | -- | -- | No |
| Benzo(g,h,i)perylene | N/A | 5,200 | UT | -- | -- | UT |

**Table 2.5**
**PRG Screen for Subsurface Soil/Subsurface Sediment**

| Analyte | PRG[a] | MDC | MDC Exceeds PRG? | UCL[b] | UCL Exceeds PRG? | Retain for Detection Frequency Screen? |
|---|---|---|---|---|---|---|
| Benzo(k)fluoranthene | 436,159 | 8,000 | No | -- | -- | No |
| Benzoic Acid | 3.69E+09 | 2,300 | No | -- | -- | No |
| bis(2-ethylhexyl)phthalate | 2.46E+06 | 71,000 | No | -- | -- | No |
| Butylbenzylphthalate | 1.84E+08 | 4,900 | No | -- | -- | No |
| Carbon Disulfide | 1.88E+07 | 160 | No | -- | -- | No |
| Carbon Tetrachloride | 97,124 | 6,200 | No | -- | -- | No |
| Chloroform | 90,270 | 130 | No | -- | -- | No |
| Chrysene | 4.36E+06 | 11,000 | No | -- | -- | No |
| cis-1,2-Dichloroethene | 1.28E+07 | 4,400 | No | -- | -- | No |
| Dibenz(a,h)anthracene | 4,362 | 1,700 | No | -- | -- | No |
| Dibenzofuran | 2.56E+06 | 7,000 | No | -- | -- | No |
| Dicamba | 2.76E+07 | 2.20 | No | -- | -- | No |
| Diethylphthalate | 7.37E+08 | 56 | No | -- | -- | No |
| Di-n-butylphthalate | 9.22E+07 | 480 | No | -- | -- | No |
| Ethylbenzene | 6.19E+07 | 62 | No | -- | -- | No |
| Fluoranthene | 3.40E+07 | 18,000 | No | -- | -- | No |
| Fluorene | 3.69E+07 | 7,100 | No | -- | -- | No |
| Fluoroacetamide | N/A | 22 | UT | -- | -- | UT |
| Hexachlorobutadiene | 255,500 | 310 | No | -- | -- | No |
| Indeno(1,2,3-cd)pyrene | 43,616 | 3,000 | No | -- | -- | No |
| Methylene Chloride | 3.13E+06 | 1,500 | No | -- | -- | No |
| Naphthalene | 1.61E+07 | 17,000 | No | -- | -- | No |
| n-Butylbenzene | N/A | 0.620 | UT | -- | -- | UT |
| N-nitrosodiphenylamine | 7.04E+06 | 17,000 | No | -- | -- | No |
| Pentachlorophenol | 202,777 | 790 | No | -- | -- | No |
| Phenanthrene | N/A | 43,000 | UT | -- | -- | UT |
| Phenol | 2.76E+08 | 2,500 | No | -- | -- | No |
| Propylcyclopentane | N/A | 7.20 | UT | -- | -- | UT |
| Pyrene | 2.55E+07 | 36,000 | No | -- | -- | No |
| Styrene | 1.59E+08 | 1.70 | No | -- | -- | No |
| Tetrachloroethene | 77,111 | 72,000 | No | -- | -- | No |
| Toluene | 3.56E+07 | 480 | No | -- | -- | No |
| Trichloroethene | 20,354 | 1,900 | No | -- | -- | No |
| Xylene[e] | 1.22E+07 | 400 | No | -- | -- | No |
| **Radionuclides (pCi/g)** | | | | | | |
| Americium-241 | 88.4 | 410 | Yes | 8.13 | No | No |
| Cesium-134 | 0.910 | -0.0186 | No | -- | -- | No |
| Cesium-137 | 2.54 | 0.340 | No | -- | -- | No |
| Gross Alpha | N/A | 4,100 | UT | -- | -- | No |
| Gross Beta | N/A | 137 | UT | -- | -- | No |
| Iodine-129 | 90.3 | 0.125 | No | -- | -- | No |
| Nickel-59 | 36,397 | 0.420 | No | -- | -- | No |
| Plutonium-238 | 68.7 | 19.8 | No | -- | -- | No |
| Plutonium-239/240 | 112 | 2,450 | Yes | 50.7 | No | No |
| Plutonium-241 | 5,981 | 178 | No | -- | -- | No |
| Radium-226 | 31 | 1.44 | No | -- | -- | No |
| **Radium-228** | **1.28** | **2.60** | **Yes** | **1.35** | **Yes** | **Yes** |
| Strontium-89/90 | 152 | 0.830 | No | -- | -- | No |
| Tritium | 288,449 | 510 | No | -- | -- | No |
| Uranium-233/234 | 291 | 14 | No | -- | -- | No |
| Uranium-235 | 12.1 | 1.70 | No | -- | -- | No |
| Uranium-238 | 337 | 64.0 | No | -- | -- | No |

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.
[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.
[c] The PRG for chromium (VI) is used.
[d] The PRG for nitrate is used.
[e] The PRG for total xylene is used.
N/A = Not available.
UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).
-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.
**Bold = Analyte retained for further consideration in the next COC selection step.**

**Table 2.6**
**Summary of the COC Selection Process**

| Analyte | MDC Exceeds PRG? | UCL Exceeds PRG? | Detection Frequency > 5%?[a] | Exceeds 30X the PRG? | Exceeds Background? | Professional Judgment-Retain? | Retain as COC? |
|---|---|---|---|---|---|---|---|
| **Surface Soil/Surface Sediment** | | | | | | | |
| Aluminum | Yes | No | -- | -- | -- | -- | No |
| **Arsenic** | **Yes** | **Yes** | **Yes** | **N/A** | **Yes** | **Yes** | **Yes** |
| Chromium | Yes | No | -- | -- | -- | -- | No |
| Manganese | Yes | No | -- | -- | -- | -- | No |
| Aroclor-1254 | Yes | No | -- | -- | -- | -- | No |
| Benzo(a)pyrene | Yes | No | -- | -- | -- | -- | No |
| Americium-241 | Yes | No | -- | -- | -- | -- | No |
| Cesium-134 | Yes | No | -- | -- | -- | -- | No |
| Cesium-137 | Yes | Yes | N/A | -- | No | -- | No |
| **Plutonium-239/240** | **Yes** | **Yes** | **N/A** | **--** | **Yes** | **Yes** | **Yes** |
| Radium-228 | Yes | Yes | N/A | -- | Yes | No | No |
| **Subsurface Soil/ Subsurface Sediment** | | | | | | | |
| Chromium | Yes | No | -- | -- | -- | -- | No |
| Lead | Yes | No | -- | -- | -- | -- | No |
| Benzo(a)pyrene | Yes | No | -- | -- | -- | -- | No |
| Americium-241 | Yes | No | -- | -- | -- | -- | No |
| Plutonium-239/240 | Yes | No | -- | -- | -- | -- | No |
| Radium-228 | Yes | Yes | N/A | N/A | No | -- | No |

[a] All radionuclide values are considered detects.
N/A = Not applicable.
-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.
**Bold = Analyte retained as a COC for risk characterization.**

**Table 3.1**
**Exposure Point Concentrations**

| Analyte | Unit | MDC[a] | UCL Value[b] | UCL Type[c] | Distribution[d] | EPC[e] |
|---|---|---|---|---|---|---|
| **Tier 1** | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | |
| Arsenic | mg/kg | 11 | 5.50 | 95% Approximate Gamma UCL | GAMMA | 5.50 |
| Plutonium-239/240 | pCi/g | 49 | 12.1 | 95% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 12.1 |
| **Tier 2** | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | |
| Arsenic | mg/kg | 6.87 | 4.69 | 95% Student's-t UCL | NORMAL | 4.69 |
| Plutonium-239/240 | pCi/g | 19.81 | 6.76 | 95% Approximate Gamma UCL | GAMMA | 6.76 |

[a] The MDC for Tier 1 is the maximum detected concentration of all samples and the MDC for Tier 2 is the maximum of the average concentration of the samples in each of the 30-acre grids in the EU.

[b] UCL = upper confidence limit.

[c] The Tier 1 UCL type is recommended by ProUCL.

[d] The Tier 1 distribution is recommended by ProUCL.

[e] The UCL is used as the EPC, unless the UCL exceeds the MDC, then the MDC is used for the EPC.

**Table 3.2**

**Chemical Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Worker**

| Exposure Route/Exposure Factor | Abbreviation | Value | Units | Source |
|---|---|---|---|---|
| **Ingestion** | | | | |
| **CI = (Cs x IRwss x EFwss x EDw x CF_3) / (BW x [ATc_wss or ATn_wss]b)** | | | | |
| Chemical Intake | CI | chemical-specific | mg/kg-day | calculated |
| Chemical concentration in soil | Cs | chemical-specific | mg/kg | Tier 1 or 2 EPC |
| Ingestion Rate of soil/sediment | IRwss | 100 | mg/day | EPA et al. 2002 |
| Exposure Frequency | EFwss | 230 | days/year | EPA et al. 2002 |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Conversion Factor | CF_3 | 1.00E-06 | kg/mg | 1 kg = 1.0E6 mg |
| Adult Body Weight | BW | 70 | kg | EPA 1991 |
| Averaging Time-Carcinogenic | ATc_wss | 25,550 | day | calculated |
| Averaging Time-Noncarcinogenic | ATnc_wss | 6,826 | day | calculated |
| | | | | |
| **Outdoor Inhalation of Suspended Particulates** | | | | |
| **CI = (Cs x IRawss x EFwss x EDw x ETwss x ETFo x MLF) / (BW x [ATc_wss or ATn_wss][b])** | | | | |
| Chemical Intake | CI | chemical-specific | mg/kg-day | calculated |
| Chemical concentration in soil | Cs | chemical-specific | mg/kg | Tier 1 or 2 EPC |
| Inhalation Rate | IRawss | 1.3 | $m^3$/hr | EPA et al. 2002 |
| Exposure Frequency | EFwss | 230 | days/year | EPA et al. 2002 |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Exposure Time | ETwss | 8 | hr/day | EPA et al. 2002 |
| Exposure Time Fraction, outdoor | ETFo | 0.5 | -- | EPA et al. 2002 |
| Mass loading, (PM 10) for inhalation[a] | MLF | 6.70E-08 | kg/$m^3$ | EPA et al. 2002 |
| Adult Body Weight | BW | 70 | kg | EPA 1991 |
| Averaging Time-Carcinogenic | ATc_wss | 25,550 | day | calculated |
| Averaging Time-Noncarcinogenic | ATnc_wss | 6,826 | day | calculated |
| | | | | |
| **Indoor Inhalation of Suspended Particulates** | | | | |
| **CI = (Cs x IRawss x EFwss x EDw x ETwss x ETFi x DFi x MLF) / (BW x [ATc_wss or ATn_wss][b])** | | | | |
| Chemical Intake | CI | chemical-specific | mg/kg-day | calculated |
| Chemical concentration in soil | Cs | chemical-specific | mg/kg | Tier 1 or 2 EPC |
| Inhalation Rate | IRawss | 1.3 | $m^3$/hr | EPA et al. 2002 |
| Exposure Frequency | EFwss | 230 | days/year | EPA et al. 2002 |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Exposure Time | ETwss | 8 | hr/day | EPA et al. 2002 |
| Exposure Time Fraction, indoor | ETFi | 0.5 | -- | EPA et al. 2002 |
| Dilution Factor, indoor inhalation | DFi | 0.7 | -- | EPA et al. 2002 |
| Mass Loading, (PM 10) for inhalation | MLF | 6.70E-08 | kg/$m^3$ | EPA et al. 2002[a] |
| Adult Body Weight | BW | 70 | kg/m3 | EPA 1991 |
| Averaging Time-Carcinogenic | ATc_wss | 25,550 | day | calculated |
| Averaging Time-Noncarcinogenic | ATnc_wss | 6,826 | day | calculated |

[a] The mass loading value is the 95th percentile of the estimated mass loading distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

[b] Carcinogenic or noncarcinogenic averaging times (Atc and Atnc, respectively) are used in equations, depending on whether carcinogenic or noncarcinogenic intakes are being calculated.

**Table 3.3**

**Radionuclide Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Worker**

| Exposure Route/Exposure Factor | Abbreviation | Value | Units | Source |
|---|---|---|---|---|
| **Ingestion** | | | | |
| **RI = Cs x IRwss x EFwss x EDw x CF_1** | | | | |
| Radionuclide Intake | RI | radionuclide-specific | pCi | calculated |
| Radionuclide concentration in soil | Cs | radionuclide-specific | pCi/g | Tier 1 or 2 EPC |
| Ingestion Rate of soil/sediment | IRwss | 100 | mg/day | EPA et al. 2002 |
| Exposure Frequency | EFwss | 230 | days/year | EPA et al. 2002 |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Conversion factor | CF_1 | 0.001 | g/mg | 1 g = 1000 mg |
| | | | | |
| **Outdoor Inhalation of Suspended Particulates** | | | | |
| **RI = Cs x IRawss x EFwss x EDw x ETwss x ETFo x MLF x CF_2** | | | | |
| Radionuclide Intake | RI | radionuclide-specific | pCi | calculated |
| Radionuclide concentration in soil | Cs | radionuclide-specific | pCi/g | Tier 1 or 2 EPC |
| Inhalation Rate | Irawss | 1.3 | $m^3$/hr | EPA et al. 2002 |
| Exposure Frequency | EFwss | 230 | days/year | EPA et al. 2002 |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Exposure Time | ETwss | 8 | hr/day | EPA et al. 2002 |
| Exposure Time Fraction, outdoor | ETFo | 0.5 | -- | EPA et al. 2002 |
| Mass loading, (PM 10) for inhalation[a] | MLF | 6.70E-08 | kg/$m^3$ | EPA et al. 2002 |
| Conversion factor | CF_2 | 1000 | g/kg | 1000 g = 1 kg |
| | | | | |
| **Indoor Inhalation of Suspended Particulates** | | | | |
| **RI = Cs x IRawss x EFwss x EDw x ETwss x ETFi x DFi x MLF x CF_2** | | | | |
| Radionuclide Intake | RI | radionuclide-specific | pCi | calculated |
| Chemical concentration in soil | Cs | radionuclide-specific | pCi/g | Tier 1 or 2 EPC |
| Inhalation Rate | Irawss | 1.3 | $m^3$/hr | EPA et al. 2002 |
| Exposure Frequency | EFwss | 230 | days/year | EPA et al. 2002 |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Exposure Time | ETwss | 8 | hr/day | EPA et al. 2002 |
| Exposure Time Fraction, indoor | ETFi | 0.5 | -- | EPA et al. 2002 |
| Dilution Factor, indoor inhalation | DFi | 0.7 | -- | EPA et al. 2002 |
| Mass Loading, (PM 10) for inhalation | MLF | 6.70E-08 | kg/$m^3$ | EPA et al. 2002[a] |
| Conversion factor | CF_2 | 1000 | g/kg | 1000 g = 1 kg |
| | | | | |
| **Outdoor External Radiation Exposure** | | | | |
| **RE = Cs x Te_A x Te_Do x EDw x ACF x GSFo** | | | | |
| Radionuclide Exposure | RE | radionuclide-specific | (pCi-yr)/g | calculated |
| Radionuclide concentration in soil | Cs | radionuclide-specific | pCi/g | Tier 1 or 2 EPC |
| Gamma exposure factor (annual) surface soil | Te_A | 0.630 | -- | EFwss / 365 day/yr |
| Gamma exposure factor (daily) outdoor | Te_Do | 0.167 | -- | ETwss x ETFo / 24 hr/day |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Area Correction Factor | ACF | 0.9 | -- | EPA et al. 2002 |
| Gamma Shielding Factor (1-SE) outdoor | GSFo | 1 | -- | EPA et al. 2002 |

| Exposure Route/Exposure Factor | Abbreviation | Value | Units | Source |
|---|---|---|---|---|
| **Indoor External Radiation Exposure** | | | | |
| **RE = Cs x Te_A x Te_Di x EDw x ACF x GSFi** | | | | |
| Radionuclide Exposure | RE | radionuclide-specific | (pCi-yr)/g | calculated |
| Radionuclide concentration in soil | Cs | radionuclide-specific | pCi/g | EPC |
| Gamma exposure factor (annual) surface soil | Te_A | 0.630 | -- | EFwss / 365 day/yr |
| Gamma exposure factor (daily) outdoor | Te_Di | 0.167 | -- | ETwss x ETFi / 24 hr/day |
| Exposure Duration | EDw | 18.7 | yr | EPA et al. 2002 |
| Area Correction Factor | ACF | 0.9 | -- | EPA et al. 2002 |
| Gamma Shielding Factor (1-SE) outdoor | GSFi | 0.4 | -- | EPA et al. 2002 |

[a] The mass loading value is the 95th percentile of the estimated mass loading distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

**Table 3.4**

**Chemical Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Visitor**

| Exposure Route/Exposure Factor | Abbreviation | Value | Units | Source |
|---|---|---|---|---|
| **Ingestion** | | | | |
| **CI = (Cs x IRagevss x EFvss x CF_3) / [Atc_vss or Atnc] [a]**<br>**where, IRageav = ((IRvss x EDav) / BW) + ((IRcvss x EDcv) / BWc)** | | | | |
| Chemical Intake | CI | chemical-specific | mg/kg-day | calculated |
| Chemical concentration in soil | Cs | chemical-specific | mg/kg | Tier 1 or 2 EPC |
| Age-adjusted Soil Ingestion Rate for chemicals | IRagevss | 57 | mg-yr/kg-day | calculated |
| Exposure Frequency | EFvss | 100 | days/year | EPA et al. 2002[b] |
| Exposure Duration - adult | EDav | 24 | yr | EPA et al. 2002 |
| Exposure Duration - child | EDcv | 6 | yr | EPA et al. 2002 |
| Conversion Factor | CF_3 | 1.00E-06 | kg/mg | 1 kg = 1.0E6 mg |
| Soil Ingestion Rate - adult | IRvss | 50 | mg/day | EPA et al. 2002 |
| Soil Ingestion Rate - child | IRcvss | 100 | mg/day | EPA et al. 2002 |
| Adult Body Weight | BW | 70 | kg | EPA 1991 |
| Child Body Weight | BWc | 15 | kg | EPA 1991 |
| Averaging Time-Carcinogenic | ATc_vss | 25,550 | day | calculated |
| Averaging Time-Noncarcinogenic | ATn_vss | 8,760 | day | calculated |
| Averaging Time-Noncarcinogenic (child) | ATn_c_vss | 2,190 | day | calculated |
| Averaging Time-Noncarcinogenic (child+adult) | ATnc | 10,950 | day | calculated |
| | | | | |
| **Outdoor Inhalation of Suspended Particulates** | | | | |
| **CI = (Cs x IRa_agevss x EFvss x MLF) / [Atc_vss or Atnc] [a]**<br>**where, IRa_agevss = (((Ira_vss x EDav) / BW) + ((IRa_cvss x EDcv) / BWc)) x ET** | | | | |
| Chemical Intake | NRI | chemical-specific | mg/kg-day | calculated |
| Chemical concentration in soil | Cs | chemical-specific | mg/kg | EPC |
| Age-averaged Inhalation Rate for chemicals | IRa_agevss | 3.7 | $m^3$-yr/kg-day | EPA et al. 2002[b] |
| Exposure Frequency | EFvss | 100 | days/year | EPA et al. 2002[b] |
| Mass loading, (PM 10) for inhalation | MLF | 6.70E-08 | kg/$m^3$ | EPA et al. 2002[c] |
| Exposure Duration - adult | EDav | 24 | yr | EPA et al. 2002 |
| Exposure Duration - child | EDcv | 6 | yr | EPA et al. 2002 |
| Adult Body Weight | BW | 70 | kg | EPA 1991 |
| Child Body Weight | BWc | 15 | kg | EPA 1991 |
| Air Inhalation Rate - adult | IRavss | 2.4 | $m^3$/hr | EPA et al. 2002 |
| Air Inhalation Rate - child | IRa_cvss | 1.6 | $m^3$/hr | EPA et al. 2002 |
| Exposure Time | ET | 2.5 | hr/day | EPA et al. 2002[b] |
| Averaging Time-Carcinogenic | ATc_vss | 25,550 | day | calculated |
| Averaging Time-Noncarcinogenic | ATn_vss | 8,760 | day | calculated |
| Averaging Time-Noncarcinogenic (child) | ATn_c_vss | 2,190 | day | calculated |
| Averaging Time-Noncarcinogenic (child+adult) | ATnc | 10,950 | day | calculated |

[a] Carcinogenic or noncarcinogenic averaging times (Atc and Atnc, respectively) are used in equations, depending on whether carcinogenic or

[b] Value is 95th percentile of visitation frequency for open space users (Jefferson County 1996)

[c] The mass loading value is the 95th percentile of the estimated mass loading distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

**Table 3.5**

**Radionuclide Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Visitor**

| Exposure Route/Exposure Factor | Abbreviation | Value | Units | Source |
|---|---|---|---|---|
| **Ingestion** | | | | |
| **RI = Cs x IRagevss_r x EFvss x (EDav + EDcv) x CF_1** | | | | |
| Radionuclide Intake | RI | chemical-specific | pCi | calculated |
| Radionuclide concentration in soil | Cs | chemical-specific | pCi/g | Tier 1 or 2 EPC |
| Age-adjusted Soil Ingestion Rate for radionuclides | IRagevss_r | 60 | mg/day | EPA et al. 2002 |
| Exposure Frequency | EFvss | 100 | days/year | EPA et al. 2002[a] |
| Exposure Duration - adult | EDav | 24 | yr | EPA et al. 2002 |
| Exposure Duration - child | EDcv | 6 | yr | EPA et al. 2002 |
| Conversion factor | CF_1 | 0.001 | g/mg | 1 g = 1000 mg |
| | | | | |
| **Outdoor Inhalation of Suspended Particulates** | | | | |
| **RI = Cs x IRa_agevss_r x EFvss x (EDav + EDcv) x ETvss x MLF x CF_2** | | | | |
| Radionuclide Intake | RI | chemical-specific | pCi | calculated |
| Radionuclide concentration in soil | Cs | chemical-specific | pCi/g | EPC |
| Age-averaged Inhalation Rate for radionuclides | IRa_agevss_r | 2.2 | $m^3$/hr | Tier 1 or 2 EPC |
| Exposure Frequency | EFvss | 100 | days/year | EPA et al. 2002[a] |
| Exposure Duration - adult | EDav | 24 | yr | EPA et al. 2002 |
| Exposure Duration - child | EDcv | 6 | yr | EPA et al. 2002 |
| Exposure Time | ETvss | 2.5 | hr/day | EPA et al. 2002[b] |
| Mass loading, (PM 10) for inhalation | MLF | 6.70E-08 | kg/$m^3$ | EPA et al. 2002[c] |
| Conversion factor | CF_2 | 1000 | g/kg | 1000 g = 1 kg |
| | | | | |
| **Outdoor External Radiation Exposure** | | | | |
| **RE = Cs x Te_Av x Te_Dv x (EDav + EDcv) x ACF x GSFo** | | | | |
| Radionuclide Exposure | RE | chemical-specific | (pCi-yr)/g | calculated |
| Radionuclide concentration in soil | Cs | chemical-specific | pCi/g | EPC |
| Gamma exposure factor (annual) surface soil | Te_Av | 0.274 | -- | EFv / 365 day/yr |
| Gamma exposure factor (daily) outdoor | Te_Dv | 0.104 | -- | ETv / 24 hr/day |
| Exposure Duration - adult | EDav | 24 | yr | EPA et al. 2002 |
| Exposure Duration - child | EDcv | 6 | yr | EPA et al. 2002 |
| Area Correction Factor | ACF | 0.9 | -- | EPA et al. 2002 |
| Gamma Shielding Factor (1-SE) outdoor | GSFo | 1 | -- | EPA et al. 2002 |

[a] Value is 95th percentile of visitation frequency for open space users (Jefferson County 1996).

[b] Value is 50th percentile of time spent for open space users (Jefferson County 1996).

[c] The mass loading value is the 95th percentile of the estimated mass loading distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

**Table 4.1**
**Chemical Cancer Slope Factors, Weight of Evidence, and Target Organs for COCs**

| Contaminant of Concern | CAS Number | Oral Slope Factor $(mg/kg\text{-}day)^{-1}$ | Source | Dermal Slope Factor $(mg/kg\text{-}day)^{-1}$ | Source | Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$ | Source | Weight of Evidence[a] | Dermal Absorption Fraction[b] | Target Organ/Cancer | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 7440-38-2 | 1.50E+00 | I | N/A | N/A | 1.51E+01 | I | A | 3.00E-02 | Skin, lungs | I |

[a] See Table 5.1 in the CRA Methodology (DOE 2005) for definitions of Weight of Evidence classifications.

[b] Dermal ABS from EPA 2001.

I = IRIS (EPA 2004a).

N/A = Not available or not applicable.

**Table 4.2**
**Chemical Non-Cancer Reference Doses, Target Organs, and Effects for COCs**

| Contaminant of Concern | CAS Number | Oral RfD (mg/kg-day) | Source | Dermal RfD (mg/kg-day) | Source | Inhalation RfD (mg/kg-day) | Source | Dermal Absorption Fraction[a] | Target Organ/Effect | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 7440-38-2 | 3.00E-04 | I | N/A | N/A | N/A | N/A | 3.00E-02 | Hyperpigmentation, keratosis and vascular complications | I |

[a] Dermal ABS from EPA 2001.
A = Heast Alternate.
I = IRIS (EPA 2004).
N/A = Not available or not applicable.

**Table 4.3**
**Radionuclide Cancer Slope Factors for COCs**

| Contaminant of Concern | CAS Number | Adult (age 18-65) Soil Oral Slope Factor[a] (risk/pCi) | Source | Age-Adjusted Soil Oral Slope Factor[b] (risk/pCi) | Source | Inhalation Slope Factor (risk/pCi) | Source | External Slope Factor (risk/yr)/(pCi/g) | Source |
|---|---|---|---|---|---|---|---|---|---|
| Plutonium-239[c] | 15117-48-3 | 1.21E-10 | R | 2.76E-10 | H | 3.33E-08 | H | 2.00E-10 | H |

[a] Used for the WRW receptor.

[b] Used for the WRV receptor.

[c] Pu-239 is used for Pu-239/240.

H = Values from HEAST for Radionuclides (EPA 2001a).

R = Values Derived for RSALS (EPA et al. 2002).

**Table 4.4**
**Radionuclide Dose Conversion Factors for COCs**

| Contaminant of Concern | Oral Dose Conversion Factor[a] (mrem/pCi) | Inhalation Dose Conversion Factor[a] (mrem/pCi) | External Dose Conversion Factor[b] (mrem/yr)/(pCi/g) |
|---|---|---|---|
| Plutonium-239 (Adult)[c] | 9.30E-04 | 0.190 | 2.95E-04 |
| Plutonium-239 (Child)[c] | 0.00160 | 0.290 | 2.95E-04 |

[a] ICRP Publication 72, 1996.

[b] Federal Guidance Report 12, EPA 402-R-93-081, September 1993.

[c] Pu-239 is used for Pu-239/240.

**Table 5.1**
**Summary of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Worker**

| EPC/Medium/ Contaminant of Concern | Chemical Cancer Risk | | | | | Non-Cancer Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ingestion | Inhalation | Dermal | Exposure Routes Total | Percent Contribution to Risk | Ingestion | Inhalation | Dermal | Exposure Routes Total | Percent Contribution to Hazard Index |
| **Tier 1** | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | |
| Arsenic | 1.98E-06 | 1.18E-07 | -- | 2.10E-06 | 100% | 0.016 | NC | NC | 0.0165 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **2.10E-06** | **100%** | | | | **0.0165** | **100%** |
| **Tier 1 WRW Total:** | | | | **2.E-06** | | | | | **0.02** | |
| **Tier 2** | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | |
| Arsenic | 1.52E-06 | 9.08E-08 | -- | 1.61E-06 | 100% | 0.013 | NC | NC | 0.0127 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **1.61E-06** | **100%** | | | | **0.0127** | **100%** |
| **Tier 2 WRW Total:** | | | | **2.E-06** | | | | | **0.01** | |

-- = Exposure route is not complete because no COCs identified or exposure route was identified as insignificant in the CRA Methodology.
NC = Not calculated, noncancer toxicity criteria were not available.

**Table 5.2**
**Summary of Radionuclide Cancer Risks and Doses for the Wildlife Refuge Worker**

| EPC/Medium/ Contaminant of Concern | Radiation Cancer Risk | | | Exposure Routes Total | Percent Contribution to Risk | Radiation Dose | | | Exposure Routes Total | Percent Contribution to Dose |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ingestion | Inhalation | External | | | Ingestion | Inhalation | External | | |
| **Tier 1** | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | |
| Plutonium-239/240 | 6.31E-07 | 1.03E-06 | 6.00E-09 | 1.67E-06 | 100% | 0.281 | 0.058 | 5.55E-04 | 0.339 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **1.67E-06** | **100%** | | | | **0.339** | **100%** |
| **Tier 1 WRW Total:** | | | | **2.E-06** | | | | | **3.4E-01** | |
| **Tier 2** | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | |
| Plutonium-239/240 | 3.52E-07 | 5.73E-07 | 3.35E-09 | 9.29E-07 | 100% | 0.179 | 0.037 | 3.53E-04 | 0.216 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **9.29E-07** | **100%** | | | | **0.216** | **100%** |
| **Tier 2 WRW Total:** | | | | **9.E-07** | | | | | **2.2E-01** | |

**Table 5.3**
**Summary of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Visitor**

| EPC/Medium/ Contaminant of Concern | Chemical Cancer Risk | | | | | Non-Cancer Hazard Quotient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ingestion | Inhalation | Dermal | Exposure Routes Total | Percent Contribution to Risk | Ingestion | Inhalation | Dermal | Exposure Routes Total | Percent Contribution to Hazard Index |
| **Tier 1** | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | |
| Arsenic | 1.84E-06 | 7.96E-08 | -- | 1.92E-06 | 100% | 0.01 | NC | NC | 0.01 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **1.92E-06** | **100%** | | | | **0.01** | **100%** |
| **Tier 1 WRV Total:** | | | | **2.E-06** | | | | | **0.01** | |
| **Tier 2** | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | |
| Arsenic | 1.42E-06 | 6.11E-08 | -- | 1.48E-06 | 100% | 0.008 | NC | NC | 0.008 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **1.48E-06** | **100%** | | | | **0.008** | **100%** |
| **Tier 2 WRV Total:** | | | | **1.E-06** | | | | | **0.008** | |

-- = Exposure route is not complete because no COCs identified or exposure route was identified as insignificant in the CRA Methodology.
NC = Not calculated, noncancer toxicity criteria were not available.

**Table 5.4**
**Summary of Radionuclide Cancer Risks and Doses for the Wildlife Refuge Visitor**

| EPC/Medium/ Contaminant of Concern | Radiation Cancer Risk | | | | | Adult Radiation Dose (mrem) | | | | | Child Radiation Dose (mrem) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ingestion | Inhalation | External | Exposure Routes Total | Percent Contribution to Risk | Ingestion | Inhalation | External | Exposure Routes Total | Percent Contribution to Dose | Ingestion | Inhalation | External | Exposure Routes Total | Percent Contribution to Dose |
| **Tier 1** | | | | | | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | | | | | | |
| Plutonium-239/240 | 6.02E-07 | 4.46E-07 | 1.87E-09 | 1.05E-06 | 100% | 0.059 | 0.013 | 1.04E-04 | 0.072 | 100% | 0.203 | 0.014 | 1.04E-04 | 0.217 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **1.05E-06** | **100%** | | | | **0.072** | **100%** | | | | **0.217** | **100%** |
| **Tier 1 WRV Total:** | | | | **1E-06** | | | | | **7.2E-02** | | | | | **2.2E-01** | |
| | | | | | | | | | | | | | | | |
| **Tier 2** | | | | | | | | | | | | | | | |
| **Surface Soil/Surface Sediment** | | | | | | | | | | | | | | | |
| Plutonium-239/240 | 3.36E-07 | 2.49E-07 | 1.04E-09 | 5.86E-07 | 100% | 0.038 | 0.008 | 6.64E-05 | 0.0458 | 100% | 0.129 | 0.009 | 6.64E-05 | 0.138 | 100% |
| **Surface Soil/Surface Sediment Total:** | | | | **5.86E-07** | **100%** | | | | **0.0458** | **100%** | | | | **0.138** | **100%** |
| **Tier 2 WRV Total:** | | | | **6E-07** | | | | | **4.6E-02** | | | | | **1.4E-01** | |

**Table 5.5**

**Summary of Chemical Risk Characterization Results**

| Exposure Scenario/EPC/Medium | Estimated Excess Lifetime Cancer Risk | Major Contributors to Chemical Cancer Risk | Estimated Non-Cancer Hazard Index | Major Contributors to Hazard Index |
|---|---|---|---|---|
| **Wildlife Refuge Worker (WRW)** | | | | |
| **Tier 1 EPC** | | | | |
| Surface Soil/Surface Sediment | 2E-06 | Arsenic (100%) | 0.02 | Arsenic (100%) |
| | | | | |
| **Tier 2 EPC** | | | | |
| Surface Soil/Surface Sediment | 2E-06 | Arsenic (100%) | 0.01 | Arsenic (100%) |
| | | | | |
| **Wildlife Refuge Visitor (WRV)** | | | | |
| **Tier 1 EPC** | | | | |
| Surface Soil/Surface Sediment | 2E-06 | Arsenic (100%) | 0.01 | Arsenic (100%) |
| | | | | |
| **Tier 2 EPC** | | | | |
| Surface Soil/Surface Sediment | 1E-06 | Arsenic (100%) | 0.008 | Arsenic (100%) |

**Table 5.6**
**Summary of Radionuclide Risk Characterization Results**

| Exposure Scenario/EPC/Medium | Estimated Excess Lifetime Cancer Risk | Major Contributors to Radiation Cancer Risk |
|---|---|---|
| **Wildlife Refuge Worker** | | |
| **Tier 1 EPC** | | |
| Surface Soil/Surface Sediment | 2E-06 | Plutonium-239/240 (100%) |
| | | |
| **Tier 2 EPC** | | |
| Surface Soil/Surface Sediment | 9E-07 | Plutonium-239/240 (100%) |
| | | |
| **Wildlife Refuge Visitor** | | |
| **Tier 1 EPC** | | |
| Surface Soil/Surface Sediment | 1E-06 | Plutonium-239/240 (100%) |
| | | |
| **Tier 2 EPC** | | |
| Surface Soil/Surface Sediment | 6E-07 | Plutonium-239/240 (100%) |

**Table 6.1**
**Detected PCOCs without PRGs in Each Medium by Analyte Suite[a]**

| PCOC | Surface Soil/Surface Sediment | Subsurface Soil/Subsurface Sediment |
|---|---|---|
| **Cations/Anions** | | |
| Sulfide | N/A | X |
| **Inorganics** | | |
| Cesium | X | X |
| Phosphorus | N/A | X |
| Silica | X | X |
| Silicon | X[b] | X |
| Total Petroleum Hydrocarbons | N/A | X |
| **Organics** | | |
| 1,2,3-Trichlorobenzene | N/A | X |
| 2-Hexanone | N/A | X[b] |
| 4-Chloro-3-methylphenol | N/A | X |
| 4-Isopropyltoluene | N/A | X[b] |
| Acenaphthylene | N/A | X[b] |
| Benzo(g,h,i)perylene | X | X |
| Fluoroacetamide | N/A | X |
| n-Butylbenzene | N/A | X |
| Phenanthrene | X | X |
| Propylcyclopentane | N/A | X |
| **Radionuclides** | | |
| Gross alpha | X | X |
| Gross beta | X | X |

[a] Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

N/A = Not Applicable. Analyte not detected or not analyzed.
X = indicates PRG is unavailable.

**Table 7.1**
**Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates and Vertebrates**

| Analyte | MDC | Terrestrial Plants | | Terrestrial Invertebrates | | Mourning Dove Herbivore | | Mourning Dove Insectivore | | American Kestrel | | Deer Mouse Herbivore | | Deer Mouse Insectivore | | Mule Deer | | Prairie Dog | | Coyote Carnivore | | Coyote Generalist | | Coyote Insectivore | | Terrestrial Receptor[a] | | Most Sensitive Receptor | Retain for Further Analysis? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | NOAEL | MDC > ESL? | Results | |
| **Inorganics (mg/kg)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Aluminum** | 33,000 | 50 | **Yes** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Terrestrial Plants | **Yes** |
| Ammonia | 3.33 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 7,316 | No | 586 | No | 37,008 | No | 26,723 | No | 2,247 | No | 2,311 | No | 2,539 | No | N/A | N/A | Deer Mouse Insectivore | No |
| Antimony | 0.880 | 5 | No | 78 | No | N/A | N/A | N/A | N/A | N/A | N/A | 10 | No | 0.90 | No | 58 | No | 19 | No | 138 | No | 13 | No | 3.85 | No | N/A | N/A | Deer Mouse Insectivore | No |
| **Arsenic** | 11 | 10 | **Yes** | 60 | No | 20 | No | 164 | No | 1,028 | No | 2.57 | **Yes** | 51 | No | 13 | No | 9.35 | **Yes** | 709 | No | 341 | No | 293 | No | N/A | N/A | Deer Mouse Herbivore | **Yes** |
| **Barium** | 280 | 500 | No | 330 | No | 159 | **Yes** | 357 | No | 1,317 | No | 930 | No | 4,427 | No | 4,766 | No | 3,224 | No | 24,896 | No | 19,838 | No | 18,369 | No | N/A | N/A | Mourning Dove Herbivore | **Yes** |
| Beryllium | 1.40 | 10 | No | 40 | No | N/A | N/A | N/A | N/A | N/A | N/A | 160 | No | 6.82 | No | 896 | No | 211 | No | 1,072 | No | 103 | No | 29 | No | N/A | N/A | Deer Mouse Insectivore | No |
| **Boron** | 15 | 0.5 | **Yes** | N/A | N/A | 30 | No | 115 | No | 167 | No | 62 | No | 422 | No | 314 | No | 237 | No | 929 | No | 6,070 | No | 1,816 | No | N/A | N/A | Terrestrial Plants | **Yes** |
| **Cadmium** | 2.60 | 32 | No | 140 | No | 28 | No | 0.71 | **Yes** | 15 | No | 60 | No | 1.56 | **Yes** | 723 | No | 198 | No | 1,360 | No | 51 | No | 10 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| Calcium | 185,000 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Cesium | 7.40 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| **Chromium[b]** | 80.5 | 1 | **Yes** | 0.4 | **Yes** | 25 | **Yes** | 1.34 | **Yes** | 14 | **Yes** | 281 | No | 16 | **Yes** | 1,461 | No | 703 | No | 4,173 | No | 250 | No | 69 | **Yes** | N/A | N/A | Terrestrial Invertebrates | **Yes** |
| **Cobalt** | 21.6 | 13 | **Yes** | N/A | N/A | 278 | No | 87 | No | 440 | No | 1,476 | No | 363 | No | 7,902 | No | 2,461 | No | 3,785 | No | 2,492 | No | 1,519 | No | N/A | N/A | Terrestrial Plants | **Yes** |
| **Copper** | 49.8 | 100 | No | 50 | No | 29 | **Yes** | 8.25 | **Yes** | 164 | No | 295 | No | 605 | No | 4,119 | No | 838 | No | 5,459 | No | 3,000 | No | 4,641 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| Iron | 27,000 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| **Lead** | 120 | 110 | **Yes** | 1,700 | No | 50 | **Yes** | 12 | **Yes** | 96 | **Yes** | 1,344 | No | 242 | No | 9,798 | No | 1,850 | No | 8,927 | No | 3,066 | No | 1,393 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| **Lithium** | 33 | 2 | **Yes** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1,882 | No | 610 | No | 10,173 | No | 3,178 | No | 18,431 | No | 5,608 | No | 2,560 | No | N/A | N/A | Terrestrial Plants | **Yes** |
| Magnesium | 8,270 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| **Manganese** | 1,200 | 500 | **Yes** | N/A | N/A | 1,032 | **Yes** | 2,631 | No | 9,917 | No | 486 | **Yes** | 4,080 | No | 2,506 | No | 1,519 | No | 14,051 | No | 10,939 | No | 19,115 | No | N/A | N/A | Deer Mouse Hervibore | **Yes** |
| **Mercury** | 0.250 | 0.3 | No | 0.1 | **Yes** | 0.20 | **Yes** | 1.00E-04 | **Yes** | 1.57 | No | 0.44 | No | 0.18 | **Yes** | 7.56 | No | 3.15 | No | 8.18 | No | 8.49 | No | 37 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| **Molybdenum** | 3 | 2 | **Yes** | N/A | N/A | 44 | No | 7.0 | No | 77 | No | 8.68 | No | 1.90 | **Yes** | 44 | No | 27 | No | 275 | No | 29 | No | 8.18 | No | N/A | N/A | Deer Mouse Insectivore | **Yes** |
| **Nickel** | 101 | 30 | **Yes** | 200 | No | 44 | **Yes** | 1.2 | **Yes** | 13 | **Yes** | 16 | **Yes** | 0.43 | **Yes** | 124 | No | 38 | **Yes** | 91 | **Yes** | 6.02 | **Yes** | 1.86 | **Yes** | N/A | N/A | Deer Mouse Insectivore | **Yes** |
| Nitrate / Nitrite[c] | 3.83 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 4,478 | No | 7,647 | No | 22,660 | No | 16,233 | No | 32,879 | No | 32,190 | No | 32,879 | No | N/A | N/A | Deer Mouse Herbivore | No |
| Potassium | 6,200 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Selenium | 0.730 | 1 | No | 70 | No | 1.61 | No | 1.0 | No | 8.48 | No | 0.87 | No | 0.75 | No | 3.82 | No | 2.80 | No | 32 | No | 12 | No | 5.39 | No | N/A | N/A | Deer Mouse Insectivore | No |
| Silica | 1,100 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Silicon | 2,160 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| **Silver** | 42.8 | 2 | **Yes** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Terrestrial Plants | **Yes** |
| Sodium | 492 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Strontium | 362 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 940 | No | 13,578 | No | 4,702 | No | 3,519 | No | 584,444 | No | 144,904 | No | 57,298 | No | N/A | N/A | Deer Mouse Herbivore | No |
| **Thallium** | 3.30 | 1 | **Yes** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 180 | No | 7.24 | No | 1,039 | No | 204 | No | 212 | No | 82 | No | 31 | No | N/A | N/A | Terrestrial Plants | **Yes** |
| **Tin** | 75.8 | 50 | **Yes** | N/A | N/A | 26 | **Yes** | 2.9 | **Yes** | 19 | **Yes** | 45 | **Yes** | 3.77 | **Yes** | 242 | No | 81 | No | 70 | **Yes** | 36 | **Yes** | 16 | **Yes** | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| Titanium | 603 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| **Uranium** | 8 | 5 | **Yes** | N/A | N/A | 685 | No | 446 | No | 2,792 | No | 970 | No | 569 | No | 5,472 | No | 1,226 | No | 7,299 | No | 3,106 | No | 2,272 | No | N/A | N/A | Terrestrial Plants | **Yes** |
| **Vanadium** | 72 | 2 | **Yes** | N/A | N/A | 503 | No | 274 | No | 1,514 | No | 64 | **Yes** | 30 | **Yes** | 358 | No | 84 | No | 341 | No | 164 | No | 121 | No | N/A | N/A | Terrestrial Plants | **Yes** |
| **Zinc** | 165 | 50 | **Yes** | 200 | No | 109 | **Yes** | 0.6 | **Yes** | 113 | **Yes** | 171 | No | 5.29 | **Yes** | 2,772 | No | 1,174 | No | 16,489 | No | 3,887 | No | 431 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| **Organics (µg/kg)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | 1.39 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1.32E+06 | No | 60,701 | No | 6.70E+06 | No | 4.70E+06 | No | 253,233 | No | 255,398 | No | 262,963 | No | N/A | N/A | Deer Mouse Insectivore | No |
| 1,2,3-Trichloropropane | 1.47 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 330,027 | No | 13,883 | No | 1.67E+06 | No | 1.17E+06 | No | 58,642 | No | 58,965 | No | 60,144 | No | N/A | N/A | Deer Mouse Insectivore | No |
| 1,2,4-Trimethylbenzene | 1.44 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| 4,4'-DDE | 5.80 | N/A | N/A | N/A | N/A | 366 | No | 8.0 | No | 22 | No | 15,484 | No | 517 | No | 78,493 | No | 54,420 | No | 2,530 | No | 2,449 | No | 2,240 | No | N/A | N/A | Mourning Dove Insectivore | No |
| 4,6-Dinitro-2-methylphenol | 390 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 12,483 | No | 560 | No | 63,246 | No | 44,283 | No | 2,345 | No | 2,363 | No | 2,427 | No | N/A | N/A | Deer Mouse Insectivore | No |
| Acenaphthene | 240 | 20,000 | No | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Terrestrial Plants | No |
| Anthracene | 330 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Benzene | 1.44 | 500 | No | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 307,359 | No | 14,934 | No | 1.56E+06 | No | 1.10E+06 | No | 61,785 | No | 62,438 | No | 64,693 | No | N/A | N/A | Terrestrial Plants | No |
| Benzo(a)anthracene | 830 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| **Benzo(a)pyrene** | 750 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 336,625 | No | 631 | **Yes** | 2.41E+06 | No | 502,521 | No | 3,062 | No | 2,971 | No | 2,756 | No | N/A | N/A | Deer Mouse Insectivore | **Yes** |
| Benzo(b)fluoranthene | 810 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Benzo(g,h,i)perylene | 240 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Benzo(k)fluoranthene | 740 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Benzoic Acid | 1,100 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| **bis(2-ethylhexyl)phthalate** | 510 | N/A | N/A | N/A | N/A | 19,547 | No | 137 | **Yes** | 398 | **Yes** | 960,345 | No | 8,071 | No | 4.93E+06 | No | 2.76E+06 | No | 42,305 | No | 40,167 | No | 34,967 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| Chlorobenzene | 2.03 | N/A | N/A | 40,000 | No | N/A | N/A | N/A | N/A | N/A | N/A | 117,455 | No | 4,750 | No | 595,322 | No | 413,812 | No | 20,175 | No | 20,258 | No | 20,576 | No | N/A | N/A | Deer Mouse Insectivore | No |
| Chrysene | 790 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Dibenz(a,h)anthracene | 92 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Dibenzofuran | 86 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 707,000 | No | 21,200 | No | 3.59E+06 | No | 2.44E+06 | No | 93,800 | No | 93,200 | No | 91,800 | No | N/A | N/A | Deer Mouse Insectivore | No |
| Dieldrin | 5.80 | N/A | N/A | N/A | N/A | 178 | No | 10 | No | 26 | No | 81 | No | 7.40 | No | 411 | No | 301 | No | 34 | No | 33 | No | 32 | No | N/A | N/A | Deer Mouse Insectivore | No |
| **Di-n-butylphthalate** | 1,000 | 200,000 | No | N/A | N/A | 989 | **Yes** | 16 | **Yes** | 42 | **Yes** | 1.21E+07 | No | 281,236 | No | 6.13E+07 | No | 4.06E+07 | No | 1.29E+06 | No | 1.27E+06 | No | 1.22E+06 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| **Endrin** | 5.10 | N/A | N/A | N/A | N/A | 106 | No | 1.4 | **Yes** | 3.74 | **Yes** | 2,462 | No | 46 | No | 12,536 | No | 8,060 | No | 215 | No | 210 | No | 197 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| Ethylbenzene | 1.29 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Fluoranthene | 1,900 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Fluorene | 230 | 200,000 | No | 30,000 | No | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Terrestrial Invertebrates | No |
| Indeno(1,2,3-cd)pyrene | 220 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Methoxychlor | 9.40 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 70,467 | No | 1,226 | No | 358,904 | No | 228,896 | No | 5,840 | No | 5,695 | No | 5,313 | No | N/A | N/A | Deer Mouse Insectivore | No |
| Naphthalene | 0.890 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 8.08E+06 | No | 27,048 | No | 5.57E+07 | No | 1.60E+07 | No | 104,269 | No | 107,146 | No | 117,177 | No | N/A | N/A | Deer Mouse Insectivore | No |
| N-Nitroso-di-n-propylamine | 400 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Phenanthrene | 1,600 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Pyrene | 1,800 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Tetrachloroethene | 1.73 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 20,713 | No | 763 | No | 105,023 | No | 72,494 | No | 3,285 | No | 3,288 | No | 3,307 | No | N/A | N/A | Deer Mouse Insectivore | No |
| Toluene | 2.26 | 200,000 | No | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 346,579 | No | 14,416 | No | 1.76E+06 | No | 1.22E+06 | No | 60,990 | No | 61,301 | No | 62,452 | No | N/A | N/A | Deer Mouse Insectivore | No |
| **Total PCB** | 3,365 | 40,000 | No | N/A | N/A | 1,141 | **Yes** | 172 | **Yes** | 882 | **Yes** | 11,892 | No | 1,244 | **Yes** | 61,287 | No | 37,963 | No | 3,320 | **Yes** | 5,190 | No | 3,681 | No | N/A | N/A | Mourning Dove Insectivore | **Yes** |
| **Radionuclides (pCi/g)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Americium-241 | 15.6 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 3,890 | No | Terrestrial Receptor | No |
| Cesium-134 | 0.100 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Cesium-137 | 2.01 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 21 | No | Terrestrial Receptor | No |
| Gross Alpha | 320 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Gross Beta | 51.1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Plutonium-238 | 1.53 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | UT |
| Plutonium-239/240 | 49 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 6,110 | No | Terrestrial Receptor | No |
| Radium-226 | 1.46 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 50.6 | No | Terrestrial Receptor | No |
| Radium-228 | 3.50 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 43.9 | No | Terrestrial Receptor | No |
| Strontium-89/90 | 1.24 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 22.5 | No | Terrestrial Receptor | No |
| Uranium-233/234 | 7.96 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 4,980 | No | Terrestrial Receptor | No |
| Uranium-235 | 0.680 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 2,770 | No | Terrestrial Receptor | No |
| Uranium-238 | 3.78 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1,580 | No | Terrestrial Receptor | No |

[a] Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.

[b] The ESLs for chromium were developed using available toxicity data based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).

[c] The ESL for nitrate is used.

N/A = Indicates no ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.2**
**Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the WBEU**

| Analyte | Terrestrial Vertebrate Exceedance? | Terrestrial Invertebrate Exceedance? | Terrestrial Plant Exceedance? |
|---|---|---|---|
| **Inorganics** | | | |
| **Aluminum** | UT | UT | **Yes** |
| Ammonia | No | UT | UT |
| Antimony | No | No | No |
| **Arsenic** | **Yes** | No | **Yes** |
| **Barium** | **Yes** | No | No |
| Beryllium | No | No | No |
| **Boron** | No | UT | **Yes** |
| **Cadmium** | **Yes** | No | No |
| Calcium | UT | UT | UT |
| Cesium | UT | UT | UT |
| **Chromium** | **Yes** | **Yes** | **Yes** |
| **Cobalt** | No | UT | **Yes** |
| **Copper** | **Yes** | No | No |
| Iron | UT | UT | UT |
| **Lead** | **Yes** | No | **Yes** |
| **Lithium** | No | UT | **Yes** |
| Magnesium | UT | UT | UT |
| **Manganese** | **Yes** | UT | **Yes** |
| **Mercury** | **Yes** | **Yes** | No |
| **Molybdenum** | **Yes** | UT | **Yes** |
| **Nickel** | **Yes** | No | **Yes** |
| Nitrate / Nitrite | No | UT | UT |
| Potassium | UT | UT | UT |
| Selenium | No | No | No |
| Silica | UT | UT | UT |
| Silicon | UT | UT | UT |
| **Silver** | UT | UT | **Yes** |
| Sodium | UT | UT | UT |
| Strontium | No | UT | UT |
| **Thallium** | No | UT | **Yes** |
| **Tin** | **Yes** | UT | **Yes** |
| Titanium | UT | UT | UT |
| **Uranium** | No | UT | **Yes** |
| **Vanadium** | **Yes** | UT | **Yes** |
| **Zinc** | **Yes** | No | **Yes** |
| **Organics** | | | |
| 1,1,2,2-Tetrachloroethane | No | UT | UT |
| 1,2,3-Trichloropropane | No | UT | UT |
| 1,2,4-Trimethylbenzene | UT | UT | UT |
| 4,4'-DDE | No | UT | UT |
| 4,6-Dinitro-2-methylphenol | No | UT | UT |
| Acenaphthene | UT | UT | No |
| Anthracene | UT | UT | UT |
| Benzene | No | UT | No |
| Benzo(a)anthracene | UT | UT | UT |
| **Benzo(a)pyrene** | **Yes** | UT | UT |

**Table 7.2**
**Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the WBEU**

| Analyte | Terrestrial Vertebrate Exceedance? | Terrestrial Invertebrate Exceedance? | Terrestrial Plant Exceedance? |
|---|---|---|---|
| Benzo(b)fluoranthene | UT | UT | UT |
| Benzo(g,h,i)perylene | UT | UT | UT |
| Benzo(k)fluoranthene | UT | UT | UT |
| Benzoic Acid | UT | UT | UT |
| **bis(2-ethylhexyl)phthalate** | **Yes** | UT | UT |
| Chlorobenzene | No | No | UT |
| Chrysene | UT | UT | UT |
| **Di-n-butylphthalate** | **Yes** | UT | No |
| Dibenz(a,h)anthracene | UT | UT | UT |
| Dibenzofuran | No | UT | UT |
| Dieldrin | No | UT | UT |
| **Endrin** | **Yes** | UT | UT |
| Ethylbenzene | UT | UT | UT |
| Fluoranthene | UT | UT | UT |
| Fluorene | UT | No | No |
| Indeno(1,2,3-cd)pyrene | UT | UT | UT |
| Methoxychlor | No | UT | UT |
| N-Nitroso-di-n-propylamine | UT | UT | UT |
| Naphthalene | No | UT | UT |
| Phenanthrene | UT | UT | UT |
| Pyrene | UT | UT | UT |
| Tetrachloroethene | No | UT | UT |
| Toluene | No | UT | No |
| **Total PCB** | **Yes** | UT | No |
| **Radionuclides** | | | |
| Americium-241 | No | UT | UT |
| Cesium-134 | UT | UT | UT |
| Cesium-137 | No | UT | UT |
| Gross Alpha | UT | UT | UT |
| Gross Beta | UT | UT | UT |
| Plutonium-238 | UT | UT | UT |
| Plutonium-239/240 | No | UT | UT |
| Radium-226 | No | UT | UT |
| Radium-228 | No | UT | UT |
| Strontium-89/90 | No | UT | UT |
| Uranium-233/234 | No | UT | UT |
| Uranium-235 | No | UT | UT |
| Uranium-238 | No | UT | UT |

UT = Uncertain toxicity; no ESL available (assessed in Section 10).
**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.3**
**Statistical Distributions and Comparison to Background for WBEU Surface Soil**

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | Background | | | WBEU | | | Test | 1 - p | Retain as ECOI? |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| **Aluminum** | 20 | NORMAL | 100 | 151 | GAMMA | 100 | WRS | 0.003 | **Yes** |
| Arsenic | 20 | NORMAL | 100 | 151 | GAMMA | 100 | WRS | 0.961 | No |
| **Barium** | 20 | NORMAL | 100 | 151 | NON-PARAMETRIC | 100 | WRS | 5.22E-05 | **Yes** |
| **Boron** | N/A | N/A | N/A | 76 | NON-PARAMETRIC | 93 | N/A | N/A | **Yes**[a] |
| Cadmium | 20 | NON-PARAMETRIC | 65 | 150 | NON-PARAMETRIC | 45 | WRS | 0.991 | No |
| **Chromium** | 20 | NORMAL | 100 | 151 | NON-PARAMETRIC | 100 | WRS | 0.001 | **Yes** |
| Cobalt | 20 | NORMAL | 100 | 151 | NORMAL | 100 | t-Test_N | 0.879 | No |
| Copper | 20 | NON-PARAMETRIC | 100 | 150 | NON-PARAMETRIC | 100 | WRS | 0.159 | No |
| Lead | 20 | NORMAL | 100 | 151 | NON-PARAMETRIC | 100 | WRS | 0.610 | No |
| **Lithium** | 20 | NORMAL | 100 | 131 | GAMMA | 92 | WRS | 1.55E-04 | **Yes** |
| **Manganese** | 20 | NORMAL | 100 | 151 | NON-PARAMETRIC | 100 | WRS | 0.091 | **Yes** |
| Mercury | 20 | NON-PARAMETRIC | 40 | 132 | NON-PARAMETRIC | 52 | WRS | 1.000 | No |
| **Molybdenum** | 20 | NORMAL | 0 | 137 | NON-PARAMETRIC | 28 | N/A | N/A | **Yes**[a] |
| **Nickel** | 20 | NORMAL | 100 | 151 | LOGNORMAL | 97 | WRS | 1.31E-04 | **Yes** |
| **Silver** | 20 | NORMAL | 0 | 142 | NON-PARAMETRIC | 25 | N/A | N/A | **Yes**[a] |
| **Thallium** | 14 | NORMAL | 0 | 151 | NON-PARAMETRIC | 21 | N/A | N/A | **Yes**[a] |
| **Tin** | 20 | NORMAL | 0 | 137 | NON-PARAMETRIC | 15 | N/A | N/A | **Yes**[a] |
| **Uranium** | N/A | N/A | N/A | 76 | NON-PARAMETRIC | 5 | N/A | N/A | **Yes**[a] |
| Vanadium | 20 | NORMAL | 100 | 151 | LOGNORMAL | 100 | WRS | 0.161 | No |
| Zinc | 20 | NORMAL | 100 | 151 | NON-PARAMETRIC | 100 | WRS | 0.420 | No |

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.
N/A = Not applicable; background data not available or not detected.
t-Test_N = Student's t-test using normal data.
WRS = Wilcoxon Rank Sum.
**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.4**
**Statistical Concentrations in Surface Soil in the WBEU[a]**

| Analyte | Total Samples | UCL Recommended by ProUCL | Distribution Recommended by ProUCL | Mean | Median | 75th Percentile | 95th Percentile | UCL | UTL | MDC |
|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | | | | | |
| Aluminum | 151 | 95% Approximate Gamma UCL | GAMMA | 14,613 | 13,000 | 17,950 | 29,500 | 15,549 | 28,000 | 33,000 |
| Barium | 151 | 95% Student's-t UCL | NON-PARAMETRIC | 135 | 125 | 156 | 230 | 142 | 230 | 280 |
| Boron | 76 | 95% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 6.82 | 6.10 | 9.43 | 13.3 | 8.64 | 13.0 | 15.0 |
| Chromium | 151 | 95% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 16.5 | 14.1 | 17.9 | 32.0 | 20.2 | 31.0 | 80.5 |
| Lithium | 131 | 95% Approximate Gamma UCL | GAMMA | 12.4 | 11.4 | 15.4 | 23.9 | 13.4 | 23.3 | 33.0 |
| Manganese | 151 | 95% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 284 | 262 | 325 | 508 | 336 | 490 | 1,200 |
| Molybdenum | 137 | 97.5% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 1.07 | 0.540 | 2.25 | 2.51 | 1.61 | 2.50 | 3.00 |
| Nickel | 151 | 95% Student's-t UCL | LOGNORMAL | 14.6 | 12.8 | 16.9 | 22.8 | 16.0 | 25.6 | 101 |
| Silver | 142 | 97.5% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 1.30 | 0.550 | 1.15 | 2.84 | 3.51 | 2.60 | 42.8 |
| Thallium | 151 | 95% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 0.417 | 0.250 | 0.498 | 1.20 | 0.564 | 1.10 | 3.30 |
| Tin | 137 | 97.5% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 7.95 | 1.40 | 12.0 | 32.5 | 14.0 | 31.0 | 75.8 |
| Uranium | 76 | 95% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 1.89 | 0.825 | 3.00 | 3.60 | 2.60 | 3.60 | 8.00 |
| **Organics (µg/kg)** | | | | | | | | | | |
| Benzo(a)pyrene | 85 | 95% Student's-t UCL | NON-PARAMETRIC | 207 | 180 | 205 | 395 | 224 | 395 | 750 |
| bis(2-ethylhexyl)phthalate | 85 | 95% Student's-t UCL | NON-PARAMETRIC | 209 | 180 | 200 | 395 | 224 | 395 | 510 |
| Endrin | 40 | 95% Student's-t UCL | NON-PARAMETRIC | 8.87 | 9.00 | 10.0 | 10.0 | 9.27 | 10.5 | 10.5 |
| Total PCBs | 81 | 97.5% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 184 | 170 | 190 | 380 | 449 | 380 | 3,365 |

[a] For inorganics and organics, one-half the detection limit used as proxy value for nondetects in computation of the statistical concentrations.
MDC = Maximum detected concentration or in some cases, maximum proxy result.
UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then MDC is used as the UCL.
UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC< UTL than the MDC is used as the UTL.

**Table 7.5**
**Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs in the WBEU**

| | Small Home Range Receptors | | | Large Home Range Receptors | | |
|---|---|---|---|---|---|---|
| **Analyte** | **EPC (UTL)** | **Limiting ESL[a]** | **EPC>ESL?** | **EPC (UCL)** | **Limiting ESL[b]** | **EPC>ESL?** |
| **Inorganics (mg/kg)** | | | | | | |
| **Aluminum** | 28,000 | 50 | **Yes** | 15,549 | N/A | N/A |
| **Barium** | 230 | 222 | **Yes** | 142 | 4,766 | No |
| **Boron** | 13.0 | 0.5 | **Yes** | 8.64 | 314 | No |
| **Chromium[c]** | 31.0 | 0.4 | **Yes** | 20.2 | 68.5 | No |
| **Lithium** | 23.3 | 2 | **Yes** | 13.4 | 2,560 | No |
| **Manganese** | 490 | 486 | **Yes** | 336 | 2,510 | No |
| **Molybdenum** | 2.50 | 1.9 | **Yes** | 1.61 | 8.18 | No |
| **Nickel** | 25.6 | 0.43 | **Yes** | 16.0 | 1.86 | **Yes** |
| **Silver** | 2.60 | 2 | **Yes** | 3.51 | N/A | N/A |
| **Thallium** | 1.10 | 1 | **Yes** | 0.564 | 53.3 | No |
| **Tin** | 31.0 | 2.9 | **Yes** | 14.0 | 16 | No |
| Uranium | 3.60 | 5 | No | 2.60 | 2,270 | No |
| **Organics (µg/kg)** | | | | | | |
| Benzo(a)pyrene | 395 | 3,160 | No | 224 | 13,800 | No |
| **bis(2-ethylhexyl)phthalate** | 395 | 137 | **Yes** | 224 | 35,000 | No |
| **Endrin** | 10.5 | 1.4 | **Yes** | 9.27 | 197 | No |
| **Total PCB** | 380 | 172 | **Yes** | 449 | 1,244 | No |

[a]Lowest ESL (threshold if available) for the plant, invertebrate, deer mouse, prairie dog, dove, or kestrel receptors.

[b]Lowest ESL (threshold if available) for the coyote and mule deer receptors.

[c] The ESLs for chromium were developed using available toxicity data based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).

N/A = not applicable, ESL not available

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.6**

**Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home-Range Receptors in the WBEU**

| Analyte | Small Home Range Receptor UTL | Receptor-Specific ESLs[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Terrestrial Invertebrate | Terrestrial Plant | American Kestrel | Mourning Dove (herbivore) | Mourning Dove (insectivore) | Deer Mouse (herbivore) | Deer Mouse (Insectivore) | Prairie Dog |
| **Inorganics (mg/kg)** | | | | | | | | | |
| Aluminum | 27,400 | **50** | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Barium | 230 | 500 | 330 | 1,860 | **222** | 506 | 930 | 4,430 | 3,220 |
| Boron | 13 | N/A | **0.5** | 167 | 30.3 | 115 | 62.1 | 422 | 237 |
| Chromium | 31 | **0.4** | **1** | **14.2** | **24.6** | **1.34** | 281 | **15.9** | 703 |
| Lithium | 23.3 | N/A | **2** | N/A | N/A | N/A | 1,880 | 610 | 3,180 |
| Manganese | 490 | N/A | 500 | 9,920 | 1,030 | 2,630 | **486** | 4,080 | 1,519 |
| Molybdenum | 2.50 | N/A | **2** | 76.7 | 44.4 | 6.97 | 8.68 | **1.9** | 27.1 |
| Nickel | 25.6 | 200 | 30 | 89.9 | 320 | **7.84** | **16.4** | **0.43** | 38.3 |
| Silver | 2.60 | N/A | **2** | N/A | N/A | N/A | N/A | N/A | N/A |
| Thallium | 1.10 | N/A | **1** | N/A | N/A | N/A | 312 | 12.5 | 350 |
| Tin | 31 | N/A | 50 | **19** | **26.1** | **2.9** | 45 | **3.77** | 80.6 |
| **Organics (µg/kg)** | | | | | | | | | |
| bis(2-ethylhexyl)phthalate | 395 | N/A | N/A | 398 | 19,547 | **137** | 960,345 | 8,071 | 2,759,555 |
| Endrin | 10.5 | N/A | N/A | **3.74** | 106 | **1.4** | 2,460 | 45.5 | 8,060 |
| Total PCB | 380 | N/A | 40,000 | 886 | 1,140 | **172** | 17,000 | 1,610 | 53,200 |

[a]Lowest ESL (threshold if available) for that receptor.

N/A = Not applicable; ESL not available (assessed in Section 10).

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.7**
**Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home-Range Receptors in the WBEU**

| Analyte | Large Home Range Receptor UCL | Receptor-Specific ESLs[a] | | | |
|---|---|---|---|---|---|
| | | Mule Deer | Coyote (carnivore) | Coyote (generalist) | Coyote (insectivore) |
| **Inorganics (mg/kg)** | | | | | |
| Nickel | 16.0 | 124 | 90.9 | **6.02** | **1.86** |

[a]Lowest ESL (threshold if available) for that receptor.

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.8**
**Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the WBEU**

| Analyte | Exceed Any NOAEL ESL? | Detection Frequency >5%? | Exceed Background?[a] | Upper-Bound EPC > Limiting ESL? | Professional Judgment - Retain? | ECOPC? | Receptor(s) of Potential Concern |
|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | |
| Aluminum | Yes | Yes | Yes | Yes | No | No | -- |
| Ammonia | No | -- | -- | -- | -- | No | -- |
| Antimony | No | -- | -- | -- | -- | No | -- |
| Arsenic | Yes | Yes | No | -- | -- | No | -- |
| Barium | Yes | Yes | Yes | Yes | No | No | -- |
| Beryllium | No | -- | -- | -- | -- | No | -- |
| Boron | Yes | Yes | N/A | Yes | No | No | -- |
| Cadmium | Yes | Yes | No | -- | -- | No | -- |
| Calcium | UT | -- | -- | -- | -- | No | -- |
| Cesium | UT | -- | -- | -- | -- | No | -- |
| **Chromium** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Terrestrial plant**<br>**Terrestrial invertebrate**<br>**American kestrel**<br>**Mourning dove (herbivore)**<br>**Mourning dove (insectivore)**<br>**Deer mouse (insectivore)** |
| Cobalt | Yes | Yes | No | -- | -- | No | -- |
| Copper | Yes | Yes | No | -- | -- | No | -- |
| Iron | UT | -- | -- | -- | -- | No | -- |
| Lead | Yes | Yes | No | -- | -- | No | -- |
| Lithium | Yes | Yes | Yes | Yes | No | No | -- |
| Magnesium | UT | -- | -- | -- | -- | No | -- |
| **Manganese** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Deer mouse (herbivore)** |
| Mercury | Yes | Yes | No | -- | -- | No | -- |
| Molybdenum | Yes | Yes | N/A | Yes | No | No | -- |
| **Nickel** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Mourning dove (insectivore)**<br>**Deer mouse (herbivore)**<br>**Deer mouse (insectivore)**<br>**Coyote (generalist)**<br>**Coyote (insectivore)** |
| Nitrate / Nitrite | No | -- | -- | -- | -- | No | -- |
| Potassium | UT | -- | -- | -- | -- | No | -- |
| Selenium | No | -- | -- | -- | -- | No | -- |
| Silica | UT | -- | -- | -- | -- | No | -- |
| Silicon | UT | -- | -- | -- | -- | No | -- |
| **Silver** | **Yes** | **Yes** | **N/A** | **Yes** | **Yes** | **Yes** | **Terrestrial plant** |
| Sodium | UT | -- | -- | -- | -- | No | -- |
| Strontium | No | -- | -- | -- | -- | No | -- |
| **Thallium** | **Yes** | **Yes** | **N/A** | **Yes** | **Yes** | **Yes** | **Terrestrial plant** |
| **Tin** | **Yes** | **Yes** | **N/A** | **Yes** | **Yes** | **Yes** | **American kestrel**<br>**Mourning dove (herbivore)**<br>**Mourning dove (insectivore)**<br>**Deer mouse (insectivore)** |
| Titanium | UT | -- | -- | -- | -- | No | -- |
| Uranium | Yes | Yes | N/A | No | -- | No | -- |
| Vanadium | Yes | Yes | No | -- | -- | No | -- |
| Zinc | Yes | Yes | No | -- | -- | No | -- |
| **Organics** | | | | | | | |
| 1,1,2,2-Tetrachloroethane | No | -- | -- | -- | -- | No | -- |
| 1,2,3-Trichloropropane | No | -- | -- | -- | -- | No | -- |
| 1,2,4-Trimethylbenzene | UT | -- | -- | -- | -- | No | -- |
| 4,4'-DDE | No | -- | -- | -- | -- | No | -- |
| 4,6-Dinitro-2-methylphenol | No | -- | -- | -- | -- | No | -- |
| Acenaphthene | No | -- | -- | -- | -- | No | -- |
| Anthracene | UT | -- | -- | -- | -- | No | -- |
| Benzene | No | -- | -- | -- | -- | No | -- |
| Benzo(a)anthracene | UT | -- | -- | -- | -- | No | -- |
| Benzo(a)pyrene | Yes | Yes | N/A | No | -- | No | -- |
| Benzo(b)fluoranthene | UT | -- | -- | -- | -- | No | -- |
| Benzo(g,h,i)perylene | UT | -- | -- | -- | -- | No | -- |
| Benzo(k)fluoranthene | UT | -- | -- | -- | -- | No | -- |
| Benzoic Acid | UT | -- | -- | -- | -- | No | -- |
| **bis(2-ethylhexyl)phthalate** | **Yes** | **Yes** | **N/A** | **Yes** | **Yes** | **Yes** | **Mourning dove (insectivore)** |
| Chlorobenzene | No | -- | -- | -- | -- | No | -- |
| Chrysene | No | -- | -- | -- | -- | No | -- |

**Table 7.8**
**Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the WBEU**

| Analyte | Exceed Any NOAEL ESL? | Detection Frequency >5%? | Exceed Background?[a] | Upper-Bound EPC > Limiting ESL? | Professional Judgment - Retain? | ECOPC? | Receptor(s) of Potential Concern |
|---|---|---|---|---|---|---|---|
| Di-n-butylphthalate | Yes | No | -- | -- | -- | No | -- |
| Dibenz(a,h)anthracene | UT | -- | -- | -- | -- | No | -- |
| Dibenzofuran | No | -- | -- | -- | -- | No | -- |
| Dieldrin | No | -- | -- | -- | -- | No | -- |
| **Endrin** | **Yes** | **Yes** | **N/A** | **Yes** | **Yes** | **Yes** | **American kestrel**<br>**Mourning dove (insectivore)** |
| Ethylbenzene | UT | -- | -- | -- | -- | No | -- |
| Fluoranthene | UT | -- | -- | -- | -- | No | -- |
| Fluorene | No | -- | -- | -- | -- | No | -- |
| Indeno(1,2,3-cd)pyrene | UT | -- | -- | -- | -- | No | -- |
| Methoxychlor | No | -- | -- | -- | -- | No | -- |
| N-Nitroso-di-n-propylamine | UT | -- | -- | -- | -- | No | -- |
| Naphthalene | No | -- | -- | -- | -- | No | -- |
| Phenanthrene | UT | -- | -- | -- | -- | No | -- |
| Pyrene | UT | -- | -- | -- | -- | No | -- |
| Tetrachloroethene | No | -- | -- | -- | -- | No | -- |
| Toluene | No | -- | -- | -- | -- | No | -- |
| **Total PCB** | **Yes** | **Yes** | **N/A** | **Yes** | **Yes** | **Yes** | **Mourning dove (insectivore)** |
| **Radionuclides** | | | | | | | |
| Americium-241 | No | -- | -- | -- | -- | No | -- |
| Cesium-134 | UT | -- | -- | -- | -- | No | -- |
| Cesium-137 | No | -- | -- | -- | -- | No | -- |
| Gross Alpha | UT | -- | -- | -- | -- | No | -- |
| Gross Beta | UT | -- | -- | -- | -- | No | -- |
| Plutonium-238 | UT | -- | -- | -- | -- | No | -- |
| Plutonium-239/240 | No | -- | -- | -- | -- | No | -- |
| Radium-226 | No | -- | -- | -- | -- | No | -- |
| Radium-228 | No | -- | -- | -- | -- | No | -- |
| Strontium-89/90 | No | -- | -- | -- | -- | No | -- |
| Uranium-233/234 | No | -- | -- | -- | -- | No | -- |
| Uranium-235 | No | -- | -- | -- | -- | No | -- |
| Uranium-238 | No | -- | -- | -- | -- | No | -- |

[a] Based on results of statistical analysis at the 0.1 level of significance.
-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.
N/A = Not applicable; background comparison could not be conducted.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).
**Bold = Chemicals retained as ECOPCs for further risk characterization.**

**Table 7.9**
**Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the WBEU**

| Analyte | MDC | Prairie Dog NOAEL ESL | MDC> NOAEL ESL? |
|---|---|---|---|
| **Inorganics (mg/kg)** | | | |
| Aluminum | 54,000 | N/A | UT |
| Ammonia | 1.44 | 26,723 | No |
| **Antimony** | 350 | 18.7 | **Yes** |
| **Arsenic** | 25.93 | 9.35 | **Yes** |
| Barium | 838 | 3,224 | No |
| Beryllium | 2.3 | 211 | No |
| Boron | 15 | 237 | No |
| Cadmium | 58.7 | 198 | No |
| Calcium | 260,000 | N/A | UT |
| Cesium | 21 | N/A | UT |
| **Chromium**[a] | 4,600 | 703 | **Yes** |
| Cobalt | 24 | 2,461 | No |
| Copper | 180 | 838 | No |
| Iron | 152,000 | N/A | UT |
| **Lead** | 8,500 | 1,850 | **Yes** |
| Lithium | 44 | 3,178 | No |
| Magnesium | 12,200 | N/A | UT |
| Manganese | 1,300 | 1,519 | No |
| **Mercury** | 3.4 | 3.15 | **Yes** |
| **Molybdenum** | 1,970 | 27.1 | **Yes** |
| **Nickel** | 1,330 | 38.3 | **Yes** |
| Nitrate / Nitrite[b] | 43.6 | 16,233 | No |
| Phosphorus | 160 | N/A | UT |
| Potassium | 13,000 | N/A | UT |
| Selenium | 1.5 | 2.80 | No |
| Silica | 1,200 | N/A | UT |
| Silicon | 2,210 | N/A | UT |
| Silver | 219 | N/A | UT |
| Sodium | 3,700 | N/A | UT |
| Strontium | 459 | 3,519 | No |
| Sulfide | 83.5 | N/A | UT |
| Thallium | 10.8 | 204 | No |
| **Tin** | 110 | 80.6 | **Yes** |
| Titanium | 650 | N/A | UT |
| Total Petroleum Hydrocarbons | 249 | N/A | UT |
| Uranium | 19 | 1,226 | No |
| Vanadium | 72 | 83.5 | No |
| Zinc | 550 | 1,174 | No |
| **Organics (ug/kg)** | | | |
| 1,1,1-Trichloroethane | 300 | 4.85E+07 | No |
| 1,1,2,2-Tetrachloroethane | 72 | 4.70E+06 | No |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.8 | N/A | UT |
| 1,1-Dichloroethene | 7 | 1.28E+06 | No |
| 1,2,3-Trichlorobenzene | 3.7 | N/A | UT |
| 1,2,4-Trichlorobenzene | 14 | 94,484 | No |
| 1,2,4-Trimethylbenzene | 11.8 | N/A | UT |

**Table 7.9**
**Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the WBEU**

| Analyte | MDC | Prairie Dog NOAEL ESL | MDC> NOAEL ESL? |
|---|---|---|---|
| 1,2-Dichlorobenzene | 0.64 | N/A | UT |
| 1,2-Dichloroethene | 110 | 1.87E+06 | No |
| 1,3,5-Trimethylbenzene | 4.7 | 855,709 | No |
| 1,3-Dichlorobenzene | 0.72 | N/A | UT |
| 1,4-Dichlorobenzene | 84 | 5.93E+06 | No |
| 2-Butanone | 8100 | 4.94E+07 | No |
| 2-Chlorophenol | 46 | 21,598 | No |
| 2-Hexanone | 0.8 | N/A | UT |
| 2-Methylnaphthalene | 83,000 | 319,121 | No |
| 4-Chloro-3-methylphenol | 37 | N/A | UT |
| 4-Isopropyltoluene | 4.15 | N/A | UT |
| 4-Methyl-2-pentanone | 94 | 859,131 | No |
| Acenaphthene | 24,000 | N/A | UT |
| Acenaphthylene | 1,100 | N/A | UT |
| Acetone | 4,890 | 247,687 | No |
| Anthracene | 8,700 | N/A | UT |
| Benzene | 14 | 1.10E+06 | No |
| Benzo(a)anthracene | 7,500 | N/A | UT |
| Benzo(a)pyrene | 11,000 | 502,521 | No |
| Benzo(b)fluoranthene | 7,100 | N/A | UT |
| Benzo(g,h,i)perylene | 5,200 | N/A | UT |
| Benzo(k)fluoranthene | 8,000 | N/A | UT |
| Benzoic Acid | 2,300 | N/A | UT |
| bis(2-ethylhexyl)phthalate | 71,000 | 2.76E+06 | No |
| Butylbenzylphthalate | 4,900 | 3.37E+06 | No |
| Carbon Disulfide | 160 | 410,941 | No |
| Carbon Tetrachloride | 6,200 | 736,154 | No |
| Chloroform | 130 | 560,030 | No |
| Chrysene | 11,000 | N/A | UT |
| cis-1,2-Dichloroethene | 4,400 | 132,702 | No |
| Dibenz(a,h)anthracene | 1,700 | N/A | UT |
| Dibenzofuran | 7,000 | 2.44E+06 | No |
| Dicamba | 2.2 | 129,003 | No |
| Diethylphthalate | 56 | 2.21E+08 | No |
| Di-n-butylphthalate | 480 | 4.06E+07 | No |
| Ethylbenzene | 62 | N/A | UT |
| Fluoranthene | 18,000 | N/A | UT |
| Fluorene | 7,100 | N/A | UT |
| Fluoroacetamide | 22 | N/A | UT |
| Hexachlorobutadiene | 310 | 150,894 | No |
| Indeno(1,2,3-cd)pyrene | 3,000 | N/A | UT |
| Methylene Chloride | 1,500 | 209,560 | No |
| Naphthalene | 17,000 | 1.60E+07 | No |
| n-Butylbenzene | 0.62 | N/A | UT |
| N-nitrosodiphenylamine | 17,000 | 2.15E+06 | No |
| Pentachlorophenol | 790 | 18,373 | No |
| Phenanthrene | 43,000 | N/A | UT |

**Table 7.9**
**Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the WBEU**

| Analyte | MDC | Prairie Dog NOAEL ESL | MDC> NOAEL ESL? |
|---|---|---|---|
| Phenol | 2,500 | 1.49E+06 | No |
| Propylcyclopentane | 7.2 | N/A | UT |
| Pyrene | 36,000 | N/A | UT |
| Styrene | 1.7 | 1.53E+06 | No |
| Tetrachloroethene | 72,000 | 72,494 | No |
| Toluene | 480 | 1.22E+06 | No |
| Total PCB | 5,900 | 37,963 | No |
| Trichloroethene | 1,900 | 32,424 | No |
| Xylene | 400 | 111,663 | No |
| **Radionuclides (pCi/g)** | | | |
| Americium-241 | 410 | 3,890 | No |
| Cesium-134 | -0.0186 | N/A | UT |
| Cesium-137 | 0.3398 | 20.8 | No |
| Gross Alpha | 4100 | N/A | UT |
| Gross Beta | 137.1 | N/A | UT |
| Iodine-129 | 0.125 | N/A | UT |
| Nickel-59 | 0.42 | N/A | UT |
| Plutonium-238 | 19.84 | N/A | UT |
| Plutonium-239/240 | 2450 | 6,110 | No |
| Plutonium-241 | 178 | N/A | UT |
| Radium-226 | 1.44 | 50.6 | No |
| Radium-228 | 2.6 | 43.9 | No |
| Strontium-89/90 | 0.83 | 22.5 | No |
| Tritium | 510 | 174,000 | No |
| Uranium-233/234 | 14 | 4,980 | No |
| Uranium-235 | 1.7 | 2,770 | No |
| Uranium-238 | 63.99 | 1,580 | No |

[a] Chromium ESL is based on Chromium VI.

[b] The ESL for nitrate was used.

N/A = No ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.10**
**Statistical Distributions and Comparison to Background for Subsurface Soil in the WBEU**

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | Background | | | WBEU | | | Test | 1 - p | Retain as ECOI? |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| **Antimony** | 28 | NON-PARAMETRIC | 7.14 | 303 | NON-PARAMETRIC | 15.2 | N/A | N/A | **Yes**[a] |
| Arsenic | 45 | NON-PARAMETRIC | 93.3 | 309 | GAMMA | 98.1 | WRS | 0.280 | No |
| Chromium | 45 | GAMMA | 100 | 309 | NON-PARAMETRIC | 100 | WRS | 0.859 | No |
| Lead | 45 | GAMMA | 100 | 309 | NON-PARAMETRIC | 99.7 | WRS | 1.000 | No |
| Mercury | 41 | NON-PARAMETRIC | 29.3 | 308 | NON-PARAMETRIC | 63.6 | WRS | 1.000 | No |
| Molybdenum | 45 | NON-PARAMETRIC | 66.7 | 304 | NON-PARAMETRIC | 50 | WRS | 1.00 | No |
| Nickel | 44 | GAMMA | 100 | 309 | NON-PARAMETRIC | 98.7 | WRS | 0.995 | No |
| Tin | 41 | NON-PARAMETRIC | 36.6 | 303 | NON-PARAMETRIC | 24.8 | WRS | 1.000 | No |

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.
Test: WRS = Wilcoxon Rank Sum
N/A = Not applicable; background data not available or not detected.
**Bold = Analyte retained for further consideration in the next ECOPC selection step.**

**Table 7.11**
**Statistical Concentrations in Subsurface Soil in the WBEU[a]**

| Analyte | Total Samples | UCL Recommended by ProUCL | Distribution Recommended by ProUCL | Mean | Median | 75th Percentile | 95th Percentile | UCL | UTL | MDC |
|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | | | | | |
| Antimony | 303 | 97.5% Chebyshev (Mean, Sd) UCL | NON-PARAMETRIC | 4.60 | 0.730 | 3.23 | 6.59 | 13.7 | 5.90 | 350 |

[a] For inorganics and organics, one-half the detection limit used as proxy value for nondetects in computation of the statistical concentrations.
MDC = Maximum detected concentration or in some cases, maximum proxy result.
UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then MDC is used as the UCL.
UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC< UTL than the MDC is used as the UTL.

**Table 7.12**
**Upper-Bound Exposure Point Concentration Comparison to tESLs in the WBEU**

| Analyte | Burrowing Receptors | | |
|---|---|---|---|
| | EPC (UTL) | tESL[a] | EPC>ESL? |
| **Inorganics (mg/kg)** | | | |
| Antimony | 5.9 | 18.7 | No |

[a] Threshold ESL (if available) for the prairie dog receptor.

**Table 7.13**
**Summary of ECOPC Screening Steps for Subsurface Soil**

| Analyte | Exceed Prairie Dog NOAEL ESL | Frequency of Detection >5% | Exceeds Background?[a] | Upper Bound EPC > Limiting ESL? | Professional Judgment - Retain? | Retain as ECOPC? |
|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | |
| Aluminum | UT | -- | -- | -- | -- | No |
| Ammonia | No | -- | -- | -- | -- | No |
| Antimony | Yes | Yes | N/A | No | -- | No |
| Arsenic | Yes | Yes | No | -- | -- | No |
| Barium | No | -- | -- | -- | -- | No |
| Beryllium | No | -- | -- | -- | -- | No |
| Boron | No | -- | -- | -- | -- | No |
| Cadmium | No | -- | -- | -- | -- | No |
| Calcium | UT | -- | -- | -- | -- | No |
| Cesium | UT | -- | -- | -- | -- | No |
| Chromium | Yes | Yes | No | -- | -- | No |
| Cobalt | No | -- | -- | -- | -- | No |
| Copper | No | -- | -- | -- | -- | No |
| Iron | UT | -- | -- | -- | -- | No |
| Lead | Yes | Yes | No | -- | -- | No |
| Lithium | No | -- | -- | -- | -- | No |
| Magnesium | UT | -- | -- | -- | -- | No |
| Manganese | No | -- | -- | -- | -- | No |
| Mercury | Yes | Yes | No | -- | -- | No |
| Molybdenum | Yes | Yes | No | -- | -- | No |
| Nickel | Yes | Yes | No | -- | -- | No |
| Nitrate / Nitrite | No | -- | -- | -- | -- | No |
| Phosphorus | UT | -- | -- | -- | -- | No |
| Potassium | UT | -- | -- | -- | -- | No |
| Selenium | No | -- | -- | -- | -- | No |
| Silica | UT | -- | -- | -- | -- | No |
| Silicon | UT | -- | -- | -- | -- | No |
| Silver | UT | -- | -- | -- | -- | No |
| Sodium | UT | -- | -- | -- | -- | No |
| Strontium | No | -- | -- | -- | -- | No |
| Sulfide | UT | -- | -- | -- | -- | No |
| Thallium | No | -- | -- | -- | -- | No |
| Tin | Yes | Yes | No | -- | -- | No |
| Titanium | UT | -- | -- | -- | -- | No |
| Uranium | No | -- | -- | -- | -- | No |
| Vanadium | No | -- | -- | -- | -- | No |
| Zinc | No | -- | -- | -- | -- | No |
| **Organics** | | | | | | |
| 1,1,1-Trichloroethane | No | -- | -- | -- | -- | No |
| 1,1,2,2-Tetrachloroethane | No | -- | -- | -- | -- | No |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | UT | -- | -- | -- | -- | No |
| 1,1-Dichloroethene | No | -- | -- | -- | -- | No |
| 1,2,3-Trichlorobenzene | UT | -- | -- | -- | -- | No |
| 1,2,4-Trichlorobenzene | No | -- | -- | -- | -- | No |
| 1,2,4-Trimethylbenzene | UT | -- | -- | -- | -- | No |
| 1,2-Dichlorobenzene | UT | -- | -- | -- | -- | No |
| 1,2-Dichloroethene | No | -- | -- | -- | -- | No |
| 1,3,5-Trimethylbenzene | No | -- | -- | -- | -- | No |
| 1,3-Dichlorobenzene | UT | -- | -- | -- | -- | No |
| 1,4-Dichlorobenzene | No | -- | -- | -- | -- | No |
| 2-Butanone | No | -- | -- | -- | -- | No |

**Table 7.13**
**Summary of ECOPC Screening Steps for Subsurface Soil**

| Analyte | Exceed Prairie Dog NOAEL ESL | Frequency of Detection >5% | Exceeds Background?[a] | Upper Bound EPC > Limiting ESL? | Professional Judgment - Retain? | Retain as ECOPC? |
|---|---|---|---|---|---|---|
| 2-Chlorophenol | No | -- | -- | -- | -- | No |
| 2-Hexanone | UT | -- | -- | -- | -- | No |
| 2-Methylnaphthalene | No | -- | -- | -- | -- | No |
| 4-Chloro-3-methylphenol | UT | -- | -- | -- | -- | No |
| 4-Isopropyltoluene | UT | -- | -- | -- | -- | No |
| 4-Methyl-2-pentanone | No | -- | -- | -- | -- | No |
| Acenaphthene | UT | -- | -- | -- | -- | No |
| Acenaphthylene | UT | -- | -- | -- | -- | No |
| Acetone | No | -- | -- | -- | -- | No |
| Anthracene | UT | -- | -- | -- | -- | No |
| Benzene | No | -- | -- | -- | -- | No |
| Benzo(a)anthracene | UT | -- | -- | -- | -- | No |
| Benzo(a)pyrene | No | -- | -- | -- | -- | No |
| Benzo(b)fluoranthene | UT | -- | -- | -- | -- | No |
| Benzo(g,h,i)perylene | UT | -- | -- | -- | -- | No |
| Benzo(k)fluoranthene | UT | -- | -- | -- | -- | No |
| Benzoic Acid | UT | -- | -- | -- | -- | No |
| bis(2-ethylhexyl)phthalate | No | -- | -- | -- | -- | No |
| Butylbenzylphthalate | No | -- | -- | -- | -- | No |
| Carbon Disulfide | No | -- | -- | -- | -- | No |
| Carbon Tetrachloride | No | -- | -- | -- | -- | No |
| Chloroform | No | -- | -- | -- | -- | No |
| Chrysene | UT | -- | -- | -- | -- | No |
| cis-1,2-Dichloroethene | No | -- | -- | -- | -- | No |
| Dibenz(a,h)anthracene | UT | -- | -- | -- | -- | No |
| Dibenzofuran | No | -- | -- | -- | -- | No |
| Dicamba | No | -- | -- | -- | -- | No |
| Diethylphthalate | No | -- | -- | -- | -- | No |
| Di-n-butylphthalate | No | -- | -- | -- | -- | No |
| Ethylbenzene | UT | -- | -- | -- | -- | No |
| Fluoranthene | UT | -- | -- | -- | -- | No |
| Fluorene | UT | -- | -- | -- | -- | No |
| Fluoroacetamide | UT | -- | -- | -- | -- | No |
| Hexachlorobutadiene | No | -- | -- | -- | -- | No |
| Indeno(1,2,3-cd)pyrene | UT | -- | -- | -- | -- | No |
| Methylene Chloride | No | -- | -- | -- | -- | No |
| Naphthalene | No | -- | -- | -- | -- | No |
| n-Butylbenzene | UT | -- | -- | -- | -- | No |
| N-nitrosodiphenylamine | No | -- | -- | -- | -- | No |
| Pentachlorophenol | No | -- | -- | -- | -- | No |
| Phenanthrene | UT | -- | -- | -- | -- | No |
| Phenol | No | -- | -- | -- | -- | No |
| Propylcyclopentane | UT | -- | -- | -- | -- | No |
| Pyrene | UT | -- | -- | -- | -- | No |
| Styrene | No | -- | -- | -- | -- | No |
| Tetrachloroethene | No | -- | -- | -- | -- | No |
| Toluene | No | -- | -- | -- | -- | No |
| Total PCB | No | -- | -- | -- | -- | No |
| Trichloroethene | No | -- | -- | -- | -- | No |
| Xylene | No | -- | -- | -- | -- | No |
| **Radionuclides** | | | | | | |
| Americium-241 | No | -- | -- | -- | -- | No |

**Table 7.13**
**Summary of ECOPC Screening Steps for Subsurface Soil**

| Analyte | Exceed Prairie Dog NOAEL ESL | Frequency of Detection >5% | Exceeds Background?[a] | Upper Bound EPC > Limiting ESL? | Professional Judgment - Retain? | Retain as ECOPC? |
|---|---|---|---|---|---|---|
| Cesium-134 | UT | -- | -- | -- | -- | No |
| Cesium-137 | No | -- | -- | -- | -- | No |
| Gross Alpha | UT | -- | -- | -- | -- | No |
| Gross Beta | UT | -- | -- | -- | -- | No |
| Iodine-129 | UT | -- | -- | -- | -- | No |
| Nickel-59 | UT | -- | -- | -- | -- | No |
| Plutonium-238 | UT | -- | -- | -- | -- | No |
| Plutonium-239/240 | No | -- | -- | -- | -- | No |
| Plutonium-241 | UT | -- | -- | -- | -- | No |
| Radium-226 | No | -- | -- | -- | -- | No |
| Radium-228 | No | -- | -- | -- | -- | No |
| Strontium-89/90 | No | -- | -- | -- | -- | No |
| Tritium | No | -- | -- | -- | -- | No |
| Uranium-233/234 | No | -- | -- | -- | -- | No |
| Uranium-235 | No | -- | -- | -- | -- | No |
| Uranium-238 | No | -- | -- | -- | -- | No |

[a] Based on results of statistical analysis at the 0.1 level of significance.

'-- = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC selection step.

N/A = Not applicable; background comparison could not be conducted.

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

**Table 8.1**
**Summary of ECOPC/Receptor Pairs**

| ECOPC | Receptors of Potential Concern |
|---|---|
| **Surface Soil** | |
| Chromium | Terrestrial plant<br>Terrestrial invertebrate<br>American kestrel<br>Mourning dove (herbivore)<br>Mourning dove (insectivore)<br>Deer mouse (insectivore) |
| Manganese | Deer mouse (herbivore) |
| Nickel | Mourning dove (insectivore)<br>Deer mouse (herbivore)<br>Deer mouse (insectivore)<br>Coyote (generalist)<br>Coyote (insectivore) |
| Silver | Terrestrial plant |
| Thallium | Terrestrial plant |
| Tin | American kestrel<br>Mourning dove (herbivore)<br>Mourning dove (insectivore)<br>Deer mouse (insectivore) |
| Bis(2-ethylhexyl)phthalate | Mourning dove (insectivore) |
| Endrin | American kestrel<br>Mourning dove (insectivore) |
| Total PCBs | Mourning dove (insectivore) |
| **Subsurface Soil** | |
| None | None |

## Table 8.2
## Surface Soil Exposure Point Concentrations for Non-PMJM Receptors

| ECOPC | Tier I Exposure Point Concentrations | | Tier II Exposure Point Concentrations | |
|---|---|---|---|---|
| | UTL | UCL | UTL | UCL |
| **Inorganics (mg/kg)** | | | | |
| Chromium | 31 | 20.2 | 22.6 | 15.1 |
| Manganese | 490 | 336 | 583 | 340 |
| Nickel | 25.6 | 16.0 | 18.3 | 13.7 |
| Silver | 2.6 | 3.51 | 1.95 | 1.85 |
| Thallium | 1.1 | 0.556 | 1.03 | 0.527 |
| Tin | 31.0 | 14.0 | 35.8 | 19.9 |
| **Organics (µg/Kg)** | | | | |
| Bis(2-ethylhexyl)phthalate | 510 | 224 | 290[a] | 210 |
| Endrin | 10.5 | 9.3 | 15.8[a] | 10.1 |
| Total PCBs | 380 | 449 | 415 | 306 |

[b]Tier 2 soil UTL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration.

**Table 8.3**
**Surface Water Exposure Point Concentrations**

| ECOPC | UTL | UCL |
|---|---|---|
| **Inorganics (mg/L)** | | |
| Chromium | 0.019 | 0.006 |
| Manganese | 0.19 | 0.093 |
| Nickel | 0.012 | 0.008 |
| Silver | 0.048 | 0.02 |
| Tin | 0.068 | 0.047 |
| Thallium | ND | |
| **Organics (µg/L)** | | |
| Bis(2-ethylhexyl)phthalate | ND | |
| Endrin | ND | |
| Total PCBs | ND | |

ND = Not detected.

**Table 8.4**
**Receptor-Specific Exposure Parameters**

| Receptor | Body Weight (kg) | Body Weight Reference | Percentage of Diet: Plant Tissue | Percentage of Diet: Invertebrate Tissue | Percentage of Diet: Bird or Mammal Tissue | Percentage of Diet: Dietary Reference | Food Ingestion Rate (kg/kg BW day$^{-1}$) | Ingestion Rate Reference | Water Ingestion Rate (L/kg BW day$^{-1}$) | Ingestion Rate Reference | Percentage of Diet as Soil | Soil Ingestion Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Non-Wildlife Terrestrial Receptors** | | | | | | | | | | | | |
| Terrestrial Plants | N/A | | | | | | | | | | | |
| Terrestrial Invertebrates | N/A | | | | | | | | | | | |
| **Vertebrate Receptors - Birds** | | | | | | | | | | | | |
| American kestrel | 0.116 | Brown and Amadon (1968) - Average value | 0 | 20 | 80 | Generalized Diet from several studies presented in the Watershed ERA DOE (1996) | 0.092 | Kolpin et al. (1980) | 0.12 | EPA (1993) - Estimated using model for all birds - Calder and Braun (1983) | 5 | Assumed value based on conservative estimates for carnivores |
| Mourning Dove (herbivore) | 0.113 | Average of adult values from CalEPA (2004) Online Database | 100 | 0 | 0 | Cowan (1952) | 0.23 | EPA (2003) | 0.12 | EPA (1993) - Estimated using model for all birds - Calder and Braun (1983) | 9.3 | Beyer et al. (1994) - Wild turkey used as a surrogate. |
| Mourning Dove (insectivore) | 0.113 | Average of adult values from CalEPA (2004) Online Database | 0 | 100 | 0 | Generalized Diet | 0.23 | EPA (2003) | 0.12 | EPA (1993) - Estimated using model for all birds - Calder and Braun (1983) | 9.3 | Beyer et al. (1994) - Wild turkey used as a surrogate. |
| **Vertebrate Receptors - Mammals** | | | | | | | | | | | | |
| Deer Mouse (herbivore) | 0.0187 | Flake (1973) | 100 | 0 | 0 | Generalized Diet | 0.111 | Cronin and Bradley (1988) | 0.19 | Ross (1930); Dice (1922) as cited in EPA (1993). | 2 | Beyer et al. (1994) |
| Deer Mouse (insectivore) | 0.0187 | Flake (1973) | 0 | 100 | 0 | Generalized Diet | 0.065 | Cronin and Bradley (1988) | 0.19 | Ross (1930); Dice (1922) as cited in USEPA 1993. | 2 | Beyer et al. (1994) |
| Coyote (generalist) | 12.75 | Bekoff (1977) - Average of male and female weights | 0 | 25 | 75 | Generalized Diet | 0.015 | Gier (1975) | 0.08 | EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983) | 5 | Beyer et al. (1994) - High end estimate for Red Fox |
| Coyote (insectivore) | 12.75 | Bekoff (1977) - Average of male and female weights | 0 | 100 | 0 | Generalized Diet | 0.015 | Gier (1975) | 0.08 | EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983) | 2.8 | Beyer et al. (1994) - Red Fox |

Receptor parameters for all receptors with the exception of the prairie dog and mourning dove were taken from the Watershed Risk Assessment (DOE 1996) and referenced to the original source.

All receptor parameters are estimates of central tendency except where noted.

All values are presented in a dry weight basis.

N/A = Not applicable.

**Table 8.5**
**Receptor Specific Intake Estimates**

| | Intake Estimates (mg/kg BW day) | | | | | |
|---|---|---|---|---|---|---|
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| **Default Exposure Estimates** | | | | | | |
| ***Chromium*** | | | | | | |
| Mourning Dove - Herbivore | | | | | | |
| Tier 1 UTL | 0.599 | N/A | N/A | 0.663 | 0.00228 | 1.26 |
| Tier 2 UTL | 0.437 | N/A | NA | 0.483 | 0.00228 | 0.922 |
| Mourning Dove - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 22.5 | N/A | 0.663 | 0.00228 | 23.2 |
| Tier 2 UTL | N/A | 16.4 | NA | 0.483 | 0.00228 | 16.9 |
| American Kestrel | | | | | | |
| Tier 1 UTL | N/A | 1.80 | 0.204 | 0.143 | 0.00228 | 2.15 |
| Tier 2 UTL | N/A | 1.31 | 0.162 | 0.104 | 0.00228 | 1.58 |
| Deer Mouse - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 6.37 | N/A | 0.0403 | 0.00361 | 6.42 |
| Tier 2 UTL | N/A | 4.64 | N/A | 0.0294 | 0.00361 | 4.68 |
| ***Manganese*** | | | | | | |
| Deer Mouse - Herbivore | | | | | | |
| Tier 1 UTL | 12.7 | N/A | N/A | 1.09 | 0.0361 | 13.9 |
| Tier 2 UTL | 15.1 | N/A | N/A | 1.29 | 0.0361 | 16.5 |
| ***Nickel*** | | | | | | |
| Mourning Dove - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 27.9 | N/A | 0.548 | 0.00144 | 28.4 |
| Tier 2 UTL | N/A | 19.9 | N/A | 0.391 | 0.00144 | 20.3 |
| Deer Mouse - Herbivore | | | | | | |
| Tier 1 UTL | 0.136 | N/A | N/A | 0.0568 | 0.00228 | 0.195 |
| Tier 2 UTL | 0.106 | N/A | N/A | 0.0406 | 0.00228 | 0.149 |
| Deer Mouse - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 7.87 | N/A | 0.0333 | 0.00228 | 7.91 |
| Tier 2 UTL | N/A | 5.63 | N/A | 0.0238 | 0.00228 | 5.65 |
| Coyote - Generalist | | | | | | |
| Tier 1 UCL | N/A | 0.284 | 0.0320 | 0.0120 | 6.40E-04 | 0.328 |
| Tier 2 UCL | N/A | 0.243 | 0.0298 | 0.0103 | 6.40E-04 | 0.284 |
| Coyote - Insectivore | | | | | | |
| Tier 1 UCL | N/A | 1.14 | N/A | 0.00672 | 6.40E-04 | 1.14 |
| Tier 2 UCL | N/A | 0.972 | N/A | 0.00575 | 6.40E-04 | 0.978 |
| ***Tin*** | | | | | | |
| Mourning Dove - Herbivore | | | | | | |
| Tier 1 UTL | 0.214 | N/A | N/A | 0.663 | 0.00816 | 0.885 |
| Tier 2 UTL | 0.247 | N/A | N/A | 0.766 | 0.00816 | 1.02 |
| Mourning Dove - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 7.13 | N/A | 0.663 | 0.00816 | 7.80 |
| Tier 2 UTL | N/A | 8.23 | N/A | 0.766 | 0.00816 | 9.01 |
| American Kestrel | | | | | | |
| Tier 1 UTL | N/A | 0.570 | 0.479 | 0.143 | 0.00816 | 1.20 |
| Tier 2 UTL | N/A | 0.659 | 0.553 | 0.165 | 0.00816 | 1.38 |
| Deer Mouse - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 2.02 | N/A | 0.0403 | 0.0129 | 2.07 |
| Tier 2 UTL | N/A | 2.33 | N/A | 0.0465 | 0.0129 | 2.39 |
| ***Bis(2-ethylhexyl)phthalate*** | | | | | | |
| Mourning Dove - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 4.09 | N/A | 0.01091 | N/A | 4.10 |
| Tier 2 UTL[a] | N/A | 2.33 | N/A | 0.00620 | N/A | 2.33 |
| ***Endrin*** | | | | | | |
| Mourning Dove - Insectivore | | | | | | |
| Tier 1 UTL | NA | 0.0751 | NA | 2.25E-04 | N/A | 0.0753 |

**Table 8.5**
**Receptor Specific Intake Estimates**

| Intake Estimates (mg/kg BW day) | | | | | | |
|---|---|---|---|---|---|---|
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| **Default Exposure Estimates** | | | | | | |
| Tier 2 UTL[a] | N/A | 0.113 | N/A | 3.38E-04 | N/A | 0.113 |
| American Kestrel | | | | | | |
| Tier 1 UTL | NA | 0.00601 | 0.0220 | 4.83E-05 | N/A | 0.0281 |
| Tier 2 UTL[a] | N/A | 0.00532 | 0.0195 | 4.28E-05 | N/A | 0.0249 |
| ***PCB (Total)*** | | | | | | |
| Mourning Dove - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 0.252 | N/A | 0.00813 | N/A | 0.261 |
| Tier 2 UTL | N/A | 0.285 | N/A | 0.00888 | N/A | 0.293 |
| **Alterative Exposure Estimates** | | | | | | |
| ***Chromium*** | | | | | | |
| Mourning Dove - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 2.18 | N/A | 0.663 | 0.00228 | 2.85 |
| Tier 2 UTL | N/A | 1.03 | N/A | 0.312 | 0.00228 | 1.34 |
| ***Nickel*** | | | | | | |
| Deer Mouse - Insectivore | | | | | | |
| Tier 1 UTL | N/A | 1.76 | N/A | 0.0333 | 0.00228 | 1.80 |
| Tier 2 UTL | N/A | 1.26 | N/A | 0.0238 | 0.00228 | 1.29 |

[b]Tier 2 soil UTL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration.
N/A = Not applicable or no value available.

**Table 9.1**
**TRVs for Terrestrial Plant and Invertebrate Receptors**

| ECOPC | Soil Concentration (mg/kg) | Endpoint | Effect Measured/Observed | Reference | Notes |
|---|---|---|---|---|---|
| **Terrestrial Plants** | | | | | |
| Chromium | 1 | Screening ESL | Value was not based on any specific study. | Efroymson et al. 1997a | Low confidence in value. |
| Silver | 2 | Screening ESL | Value based on unspecified effects. | Efroymson et al. 1997a | Low confidence in value. |
| Thallium | 1 | Screening ESL | Value based on unspecified effects. | Efroymson et al. 1997a | Low confidence in value. |
| **Terrestrial Invertebrates** | | | | | |
| Chromium | 0.4 | Screening ESL | Value based on lowest concentration tested and then adjusted by an uncertainty factor of 5. | Efroymson et al. 1997b | Low confidence in value. |

**Table 9.2**
**TRVs for Terrestrial Vertebrate Receptors**

| ECOPC | NOAEL (mg/kg day) | NOAEL Endpoint | LOAEL (mg/kg day) | LOAEL Endpoint | TRV Source | Uncertainty Factor | Final NOAEL (mg/kg day) | Threshold (mg/kg day) | Rationale For Calculation | TRV Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| **Birds** | | | | | | | | | | |
| Chromium (III) | 1 | No effect on black duckling survival | 5 | Reduction in black duckling survival | Sample et al. (1996) | 1 | 1 | N/A | Threshold was not calculated. | High |
| Chromium (VI) | ***No Values Available*** | | | | | | | | | N/A |
| Nickel | 1.38 | No increase in tremors or toe and leg joint edema | 55.26 | Increase in tremors and toe and knee joint edema in mallard | PRC (1994) | 1 | 1.38 | 8.7 | The nature of the effect is not likely to cause a significant effect on growth, reproduction or survival. Thus, the data satisfy the requirements described in the text for calculating a threshold. | High |
| Tin (Butyltins) | 0.73 | No change in Japanese quail growth and reproduction | 18.34 | Decrease in Japanese quail reproduction | PRC (1994) | 1 | 0.73 | N/A | Threshold was not calculated. | High |
| bis(2-ethylhexyl)phthalate | 1.1 | No reproductive effects in ringed doves | 214 | Increase in European starling body weight. | Sample et al. (1996)/O'Shea and Stafford (1980) | 1 | 1.1 | N/A | Threshold was not calculated. | NOAEL High/LOAEL Low |
| Endrin | 0.01 | NOAEL estimated from LOAEL | 0.1 | Decrease in hatchling success and egg production in screech owls | Sample et al. (1996) | 1 | 0.01 | N/A | NOAEL was estimated from the LOAEL. | High |
| Total PCBs | 0.09 | NOAEL was estimated from LOAEL | 1.27 | Decrease in egg hatchability | PRC (1994) | 1 | 0.09 | N/A | NOAEL was estimated from LOAEL | High |
| **Mammals** | | | | | | | | | | |
| Chromium (III) | 2,737 | No effects on rat reproduction and life span | N/A | No effects at the highest study dose | Sample et al. (1996) | 1 | 2,737 | N/A | No LOAEL was presented. | High |

**Table 9.2**
**TRVs for Terrestrial Vertebrate Receptors**

| ECOPC | NOAEL (mg/kg day) | NOAEL Endpoint | LOAEL (mg/kg day) | LOAEL Endpoint | TRV Source | Uncertainty Factor | Final NOAEL (mg/kg day) | Threshold (mg/kg day) | Rationale For Calculation | TRV Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| Chromium (VI) | 3.28 | No effects on rat body weight or food consumption | 13.14 | Increased mortality in rats | Sample et al. (1996) | 1 | 3.28 | N/A | Threshold was not calculated. | High |
| Manganese | 13.7 | No change in mouse testicle weight | 159.1 | Decrease in mouse testicle weight | PRC (1994) | 1 | 13.7 | NA | The original paper was not reviewed. Not enough information was available to calculate the threshold TRV. | High |
| Nickel | 0.133 | NOAEL was estimated from LOAEL | 1.33 | Increase in pup mortality in rats | PRC (1994) | 1 | 0.133 | N/A | NOAEL was estimated from LOAEL | High |
| Tin (Butyltins) | 0.25 | No systemic effects | 15 | Midrange of effects less than mortality | PRC (1994) | 1 | 0.25 | N/A | Threshold was not calculated. | High |

TRV Confidence:
N/A = No TRV has been identified or the TRV has been deemed unacceptable for use in ECOPC selection.
Low = TRVs that have data for only one species looking at one endpoint (non-mortality) and from one primary literature source.
Moderate = TRVs that have multiple primary literature sources looking at one endpoint (non-mortality or mortality) but with only one species evaluated.
Good = For TRVs that have either multiple species with one endpoint from multiple studies or those TRVs with multiple species and multiple endpoints from only one study.
High = For TRVs that have multiple study sources looking at multiple endpoints and more than one species.
Very High = All EcoSSLs (EPA 2003a) will be assigned this level of confidence by default.

**Table 10.1**
**Hazard Quotient Summary For Non-PMJM Receptors**

| ECOPC | Receptor | BAF | EPC | Hazard Quotients (HQs) Based on Default TRVs | Hazard Quotients (HQs) Based on Refined Analysis |
|---|---|---|---|---|---|
| Chromium | Terrestrial Plant | N/A | Tier 1 | ***NOEC*** UTL = 31 | ***NOEC*** UTL = 3 ***LOEC*** UTL = 1 |
| | | | Tier 2 | ***NOEC*** UTL = 23 | ***NOEC*** UTL = 1 ***LOEC*** UTL = 0.5 |
| | Terrestrial Invertebrate | N/A | Tier 1 | ***NOEC*** UTL = 78 | ***NOEC*** N/A ***LOEC*** UTL = 0.9 |
| | | | Tier 2 | ***NOEC*** UTL = 57 | ***NOEC*** N/A ***LOEC*** UTL = 0.4 |
| | American kestrel | Default | Tier 1 | ***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.4 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.3 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Mourning Dove (Herbivore) | Default | Tier 1 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.3 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 0.9 ***LOAEL*** UTL = 0.2 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Mourning Dove (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 23 ***LOAEL*** UTL = 5 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 17 ***LOAEL*** UTL = 3 | Not Calculated |
| | | Median | Tier 1 | ***NOAEL*** UTL = 3 ***LOAEL*** UTL = 0.6 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.4 | Not Calculated |

**Table 10.1**
**Hazard Quotient Summary For Non-PMJM Receptors**

| ECOPC | Receptor | BAF | EPC | Hazard Quotients (HQs) Based on Default TRVs | Hazard Quotients (HQs) Based on Refined Analysis |
|---|---|---|---|---|---|
| Chromium (con't) | Deer Mouse (Insectivore) | Default Chromium (VI) | Tier 1 | ***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.5 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.4 | Not Calculated |
| | | Default Chromium (III) | Tier 1 | ***NOAEL*** UTL = 0.002 ***LOAEL*** N/A | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 0.002 ***LOAEL*** N/A | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| Manganese | Deer Mouse (Herbivore) | Default | Tier 1 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.09 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.1 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| Nickel | Mourning Dove (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 21 ***LOAEL*** UTL = 0.5 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 15 ***LOAEL*** UTL = 0.4 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Deer Mouse (Herbivore) | Default | Tier 1 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.1 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.1 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |

**Table 10.1**
**Hazard Quotient Summary For Non-PMJM Receptors**

| ECOPC | Receptor | BAF | EPC | Hazard Quotients (HQs) | |
|---|---|---|---|---|---|
| | | | | Based on Default TRVs | Based on Refined Analysis |
| Nickel (con't) | Deer Mouse (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 59 ***LOAEL*** UTL = 6 | ***NOAEL*** UTL = 0.2 ***LOAEL*** UTL = 0.1 |
| | | | Tier 2 | ***NOAEL*** UTL = 42 ***LOAEL*** UTL = 4 | ***NOAEL*** UTL = 0.1 ***LOAEL*** UTL = 0.07 |
| | | Median | Tier 1 | ***NOAEL*** UTL = 14 ***LOAEL*** UTL = 1 | ***NOAEL*** UTL = 0.04 ***LOAEL*** UTL = 0.02 |
| | | | Tier 2 | ***NOAEL*** UTL = 10 ***LOAEL*** UTL = 0.97 | ***NOAEL*** UTL = 0.03 ***LOAEL*** UTL = 0.02 |
| | Coyote (Generalist) | Default | Tier 1 | ***NOAEL*** UTL = 4 ***LOAEL*** UTL = 0.4 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 3 ***LOAEL*** UTL = 0.3 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Coyote (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 14 ***LOAEL*** UTL = 1 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 10 ***LOAEL*** UTL = 0.98 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| Silver | Terrestrial Plant | N/A | Tier 1 | ***ESL*** UTL = 1 | Not Calculated |
| | | | Tier 2 | ***ESL*** UTL = 0.98 | Not Calculated |
| Thallium | Terrestrial Plant | N/A | Tier 1 | ***ESL*** UTL = 1 | Not Calculated |
| | | | Tier 2 | ***ESL*** UTL = 1 | Not Calculated |

**Table 10.1**
**Hazard Quotient Summary For Non-PMJM Receptors**

| ECOPC | Receptor | BAF | EPC | Hazard Quotients (HQs) | |
|---|---|---|---|---|---|
| | | | | Based on Default TRVs | Based on Refined Analysis |
| Tin | American kestrel | Default | Tier 1 | ***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.07 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.08 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Mourning Dove (Herbivore) | Default | Tier 1 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.05 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.06 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Mourning Dove (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 11 ***LOAEL*** UTL = 0.4 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 12 ***LOAEL*** UTL = 0.5 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Deer Mouse (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 8 ***LOAEL*** UTL = 0.1 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 10 ***LOAEL*** UTL = 0.2 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| Bis(2-ethylhexyl)phthalate | Mourning Dove (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 4 ***LOAEL*** UTL = 0.02 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL[a] = 2 ***LOAEL*** UTL[a] = 0.01 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |

**Table 10.1**
**Hazard Quotient Summary For Non-PMJM Receptors**

| ECOPC | Receptor | BAF | EPC | Hazard Quotients (HQs) | |
|---|---|---|---|---|---|
| | | | | Based on Default TRVs | Based on Refined Analysis |
| Endrin | American kestrel | Default | Tier 1 | ***NOAEL*** UTL = 3 ***LOAEL*** UTL = 0.3 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 4 ***LOAEL*** UTL = 0.4 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| | Mourning Dove (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 8 ***LOAEL*** UTL = 0.8 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL[a] = 11 ***LOAEL*** UTL[a] = 1 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |
| Total PCB | Mourning Dove (Insectivore) | Default | Tier 1 | ***NOAEL*** UTL = 3 ***LOAEL*** UTL = 0.2 | Not Calculated |
| | | | Tier 2 | ***NOAEL*** UTL = 3 ***LOAEL*** UTL = 0.2 | Not Calculated |
| | | Median | Tier 1 | Not Calculated | Not Calculated |
| | | | Tier 2 | Not Calculated | Not Calculated |

[b]Tier 2 soil UTL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration.

Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology.

All HQ Calculations are provided in Attachment 4.

Discussion of the chemical-specific uncertainties are provided in Attachment 5.

**Table 10.2**
**Tier 2 Grid Cell Hazard Quotients for Surface Soil in the WBEU**

| ECOPC | Most Sensitive Receptor | Number of Grid Cells | Percent of Tier 2 Grid Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | NOAEL TRV | | | | LOAEL TRV | | | |
| | | | HQ < 1 | HQ > 1 <5 | HQ > 5 <10 | HQ > 10 | HQ < 1 | HQ > 1 <5 | HQ > 5 <10 | HQ > 10 |
| **Inorganics** | | | | | | | | | | |
| Chromium | Mourning Dove - Insectivore | 37 | 0 | 0 | 51 | 49 | 0 | 100 | 0 | 0 |
| Manganese | Deer Mouse - Herbivore | 37 | 92 | 8 | 0 | 0 | 100 | 0 | 0 | 0 |
| Nickel | Deer Mouse - Insectivore | 37 | 0 | 0 | 0 | 100 | 0 | 97 | 3 | 0 |
| Tin | Mourning Dove - Insectivore | 37 | 11 | 62 | 16 | 11 | 100 | 0 | 0 | 0 |
| **Organics** | | | | | | | | | | |
| Bis(2-ethylhexyl)phthalate | Mourning Dove - Insectivore | 34 | 15 | 85 | 0 | 0 | 100 | 0 | 0 | 0 |
| Endrin | Mourning Dove - Insectivore | 34 | 0 | 6 | 91 | 3 | 97 | 3 | 0 | 0 |
| Total PCBs | Mourning Dove - Insectivore | 34 | 15 | 85 | 0 | 0 | 100 | 0 | 0 | 0 |

N/A = No value available

The limiting receptor is chosen as the receptor with the lowest ESL.

Default exposure model and TRVs used.

**Table 11.1**
**Summary of Risk Characterization Results for the WBEU**

| Analyte | Ecological Receptors | Result of Risk Characterization | Risk Description Conclusion |
|---|---|---|---|
| **Surface Soil - Non-PMJM Receptors** | | | |
| Chromium | Terrestrial plants | Tier 1 and Tier 2 HQs >1 using default TRV.<br>Tier 1 and Tier 2 HQs >=1 using alternate NOEC.<br>Tier 1 and Tier 2 HQs <=1 using alternate LOEC. | Low Risk |
| | Terrestrial invertebrate | Tier 1 and Tier 2 HQs >1 using default TRV.<br>Tier 1 and Tier 2 HQs <1 using alternate LOEC. | Low Risk |
| | American kestrel | NOAEL HQs >= 1 for default exposures and TRVs.<br>LOAEL HQs <1 for default exposures and TRVs. | Low Risk |
| | Mourning dove (herbivore) | NOAEL HQs <=1 for default exposures and TRVs.<br>LOAEL HQs <1 for default exposures and TRVs. | Low Risk |
| | Mourning dove (insectivore) | NOAEL HQs >1 for default exposures and TRVs.<br>LOAEL HQs >1 for default exposures and TRVs.<br>NOAEL HQs >1 for alternative exposures and default TRVs.<br>LOAEL HQ <1 for alternative exposures and default TRVs. | Low Risk |
| | Deer mouse (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Deer mouse (Insectivore) | NOAEL HQs >=1 for default exposures and Cr VI TRV.<br>LOAEL HQs <1 for default exposures and Cr VI TRV.<br>NOAEL HQs <1 for default exposures and Cr III TRV. | Low Risk |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |
| Manganese | Terrestrial plants | Not an ECOPC. | Not an ECOPC. |
| | Terrestrial invertebrate | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | American kestrel | Not an ECOPC. | Not an ECOPC. |
| | Mourning dove (herbivore) | Not an ECOPC | Not an ECOPC |
| | Mourning dove (insectivore) | Not an ECOPC | Not an ECOPC |
| | Deer mouse (herbivore) | NOAEL HQ <= 1 for default exposures.<br>LOAEL HQs <1for default exposures. | Low Risk |
| | Deer mouse (Insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |

**Table 11.1**
**Summary of Risk Characterization Results for the WBEU**

| Analyte | Ecological Receptors | Result of Risk Characterization | Risk Description Conclusion |
|---|---|---|---|
| Nickel | Terrestrial plants | Not an ECOPC. | Not an ECOPC. |
| | Terrestrial invertebrate | Not an ECOPC. | Not an ECOPC. |
| | American kestrel | Not an ECOPC. | Not an ECOPC. |
| | Mourning dove (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Mourning dove (insectivore) | NOAEL HQs > 1 for default exposures and TRVs.<br>LOAEL HQs <1 for default exposures and TRVs. | Low Risk |
| | Deer mouse (herbivore) | NOAEL HQs = 1 for default exposures and TRVs.<br>LOAEL HQs <1 for default exposures and TRVs. | Low Risk |
| | Deer mouse (insectivore) | NOAEL HQs > 1 for default exposures and TRVs.<br>LOAEL HQs >1 for default exposures and TRVs.<br>NOAEL and LOAEL HQs < 1 for default exposures and alternative TRVs.<br>NOAEL and LOAEL HQs < 1 for alternative exposures and alternative TRVs. | Low Risk |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | NOAEL HQs >1 for default exposures and TRVs.<br>LOAEL HQs <1 for default exposures and TRVs. | Low Risk |
| | Coyote (insectivore) | NOAEL HQs >1 for default exposures and TRVs.<br>LOAEL HQs <=1 for default exposures and TRVs. | Low Risk |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |
| Silver | Terrestrial plants | Tier 1 UTL = 1 using default TRV.<br>Tier 2 UTL < 1 using default TRV. | Low Risk |
| | Terrestrial invertebrate | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | American kestrel | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Mourning dove (herbivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Mourning dove (insectivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Deer mouse (herbivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Deer mouse (insectivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Prairie dog | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Coyote (carnivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Coyote (generalist) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Coyote (insectivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Mule Deer | Not an ECOPC[a]. | ECOPC of Uncertain Risk |

**Table 11.1**
**Summary of Risk Characterization Results for the WBEU**

| Analyte | Ecological Receptors | Result of Risk Characterization | Risk Description Conclusion |
|---|---|---|---|
| Thallium | Terrestrial plants | Tier 1 and Tier 2 UTL = 1 using default TRV. | Low Risk |
| | Terrestrial invertebrate | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | American kestrel | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Mourning dove (herbivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Mourning dove (insectivore) | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Deer mouse (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Deer mouse (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |
| Tin | Terrestrial plants | Not an ECOPC. | Not an ECOPC. |
| | Terrestrial invertebrate | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | American kestrel | NOAEL HQs >1 for default exposures and TRVs<br>LOAEL HQs < 1 for default exposures and TRVs. | Low Risk |
| | Mourning dove (herbivore) | NOAEL HQs = 1 for default exposures and TRVs.<br>LOAEL HQs < 1 for default exposures and TRVs. | Low Risk |
| | Mourning dove (insectivore) | NOAEL HQs = 1 for default exposures and TRVs.<br>LOAEL HQs < 1 for default exposures and TRVs. | Low Risk |
| | Deer mouse (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Deer mouse (insectivore) | NOAEL HQs > 1 for default exposures and TRVs.<br>LOAEL HQs <1 for default exposures and TRVs | Low Risk |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |
| Bis(2-ethylhexyl)phthalate | Terrestrial plants | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Terrestrial invertebrate | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | American kestrel | Not an ECOPC | Not an ECOPC |
| | Mourning dove (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Mourning dove (insectivore) | NOAEL HQs > 1 for default exposure and TRVs.<br>LOAEL HQs < 1 for default exposure and TRVs. | Low Risk |
| | Deer mouse (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Deer mouse (Insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |

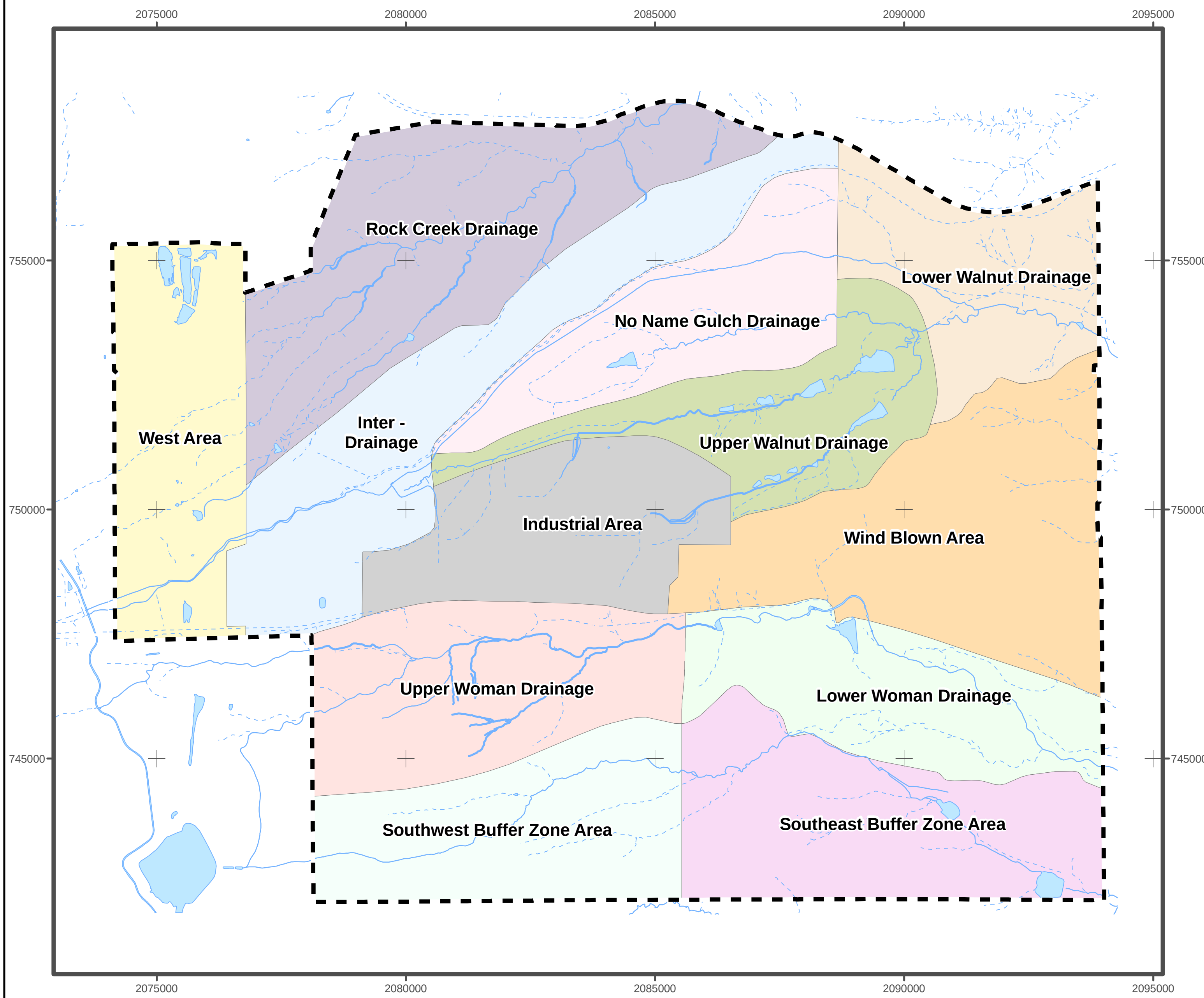
**Table 11.1**
**Summary of Risk Characterization Results for the WBEU**

| Analyte | Ecological Receptors | Result of Risk Characterization | Risk Description Conclusion |
|---|---|---|---|
| Endrin | Terrestrial plants | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | Terrestrial invertebrate | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | American kestrel | NOAEL HQs > 1 for default exposure and TRVs.<br>LOAEL HQs <1 for default exposure and TRVs. | Low Risk |
| | Mourning dove (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Mourning dove (insectivore) | NOAEL HQs > 1 for default exposure and TRVs.<br>LOAEL HQs <=1 for default exposure and TRVs. | Low Risk |
| | Deer mouse (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Deer mouse (Insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |
| Total PCBs | Terrestrial plants | Not an ECOPC. | Not an ECOPC. |
| | Terrestrial invertebrate | Not an ECOPC[a]. | ECOPC of Uncertain Risk |
| | American kestrel | Not an ECOPC | Not an ECOPC. |
| | Mourning dove (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Mourning dove (insectivore) | NOAEL HQs > 1 for default exposure and TRVs.<br>LOAEL HQs <1 for default exposure and TRVs. | Low Risk |
| | Deer mouse (herbivore) | Not an ECOPC. | Not an ECOPC. |
| | Deer mouse (Insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Prairie dog | Not an ECOPC. | Not an ECOPC. |
| | Coyote (carnivore) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (generalist) | Not an ECOPC. | Not an ECOPC. |
| | Coyote (insectivore) | Not an ECOPC. | Not an ECOPC. |
| | Mule Deer | Not an ECOPC. | Not an ECOPC. |
| **Surface Soil - PMJM Receptors** | | | |
| None | The small areas of PMJM habitat located within the WBEU were evaluated in the UWNEU and LWOEU. | | |
| **Subsurface Soil** | | | |
| None | Prairie dog | No ECOPCs. | No ECOPCs. |

[a]ESL was not available. Analyte evaluated in Section 10.

# FIGURES

Figure 1.1
Rocky Flats Environmental
Technology Site
Exposure Units




KEY

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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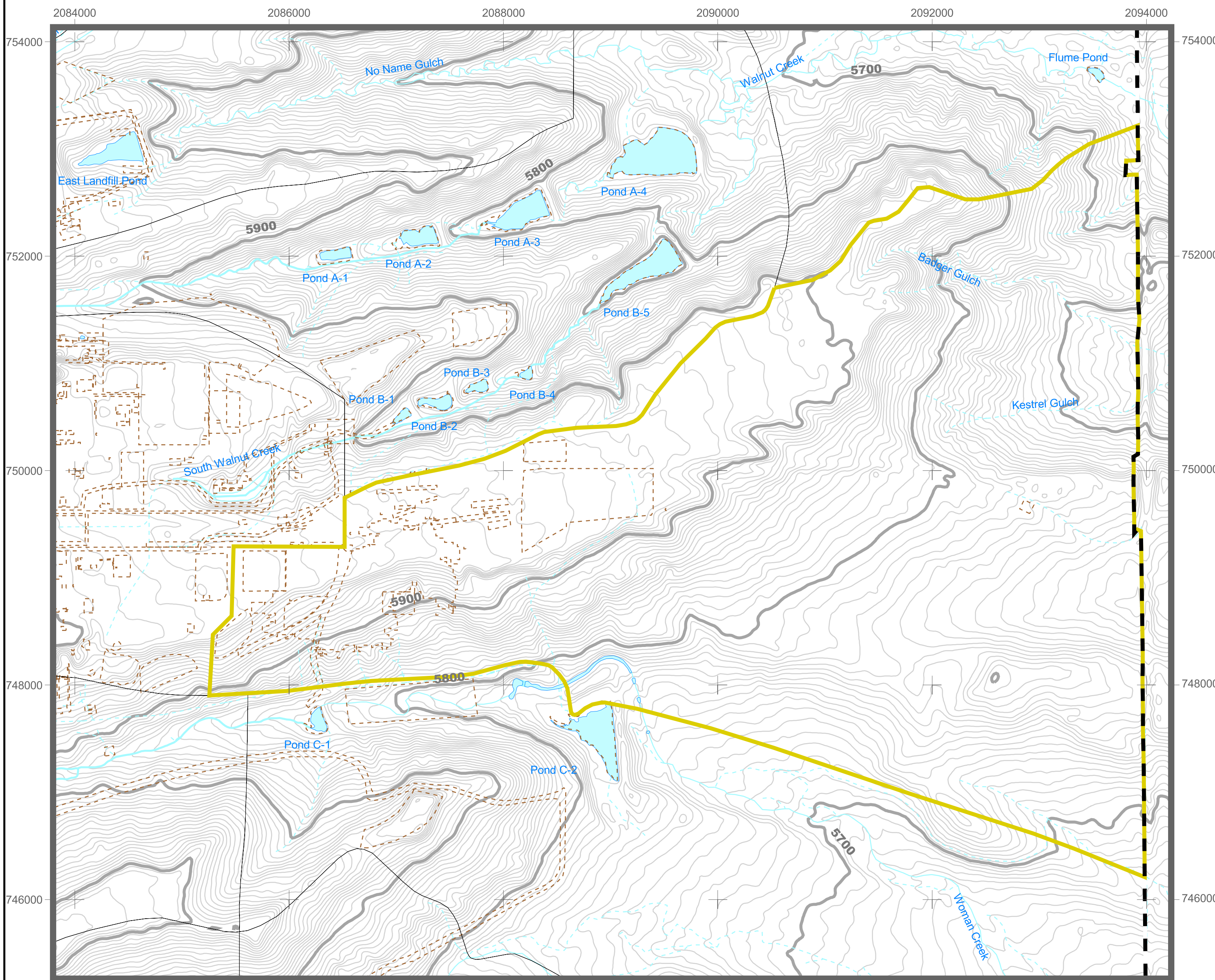


Figure 1.2
Topography and Historical IHSS Locations in the Wind Blown Area Exposure Unit

KEY

- Wind Blown Area EU
- Historical IHSS/PAC
- Topographic contour interval = 5 ft.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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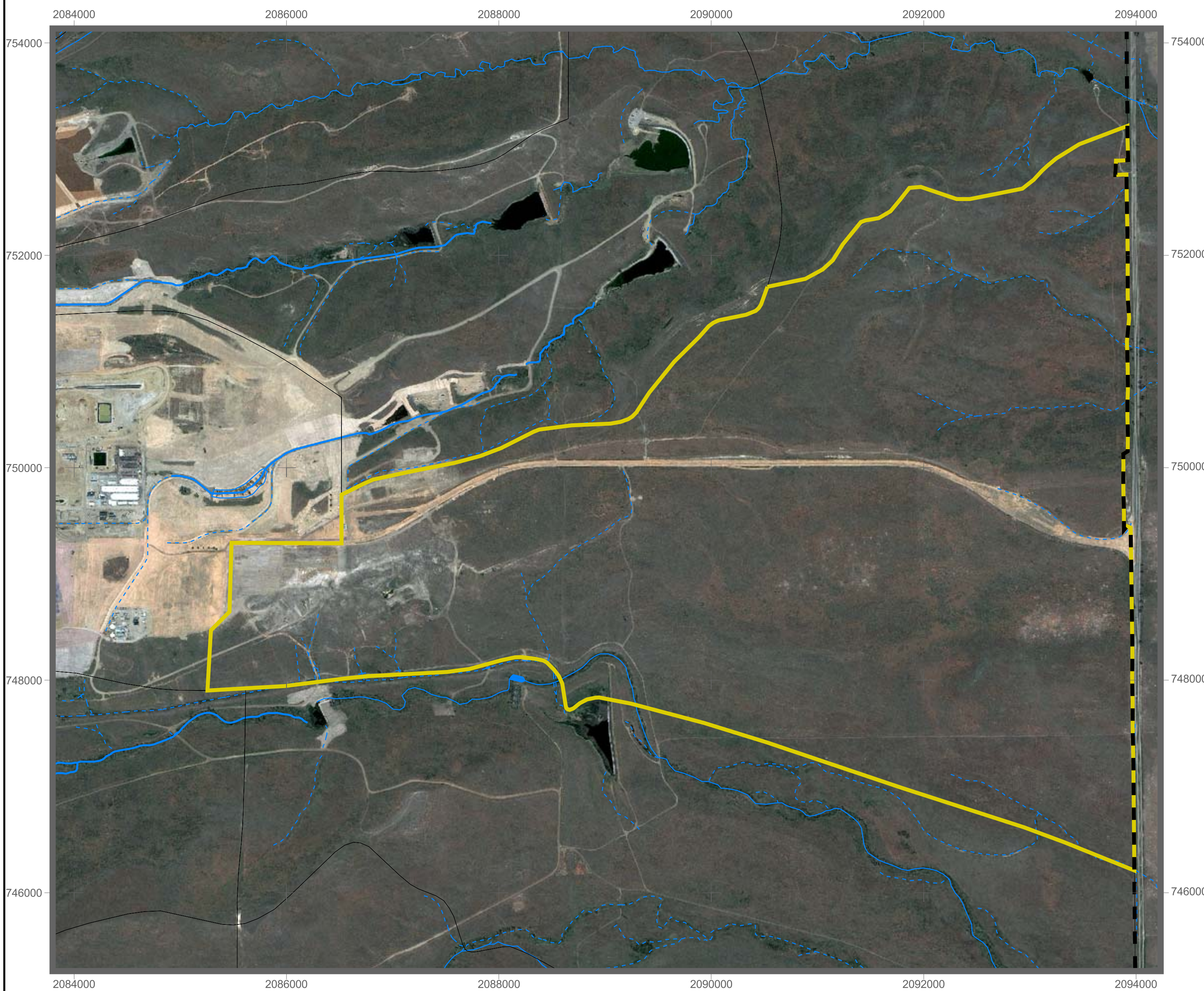


Figure 1.3
Aerial Photograph of the
Wind Blown Area
Exposure Unit
July 2005

KEY

Wind Blown Area EU

Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N
W
E
S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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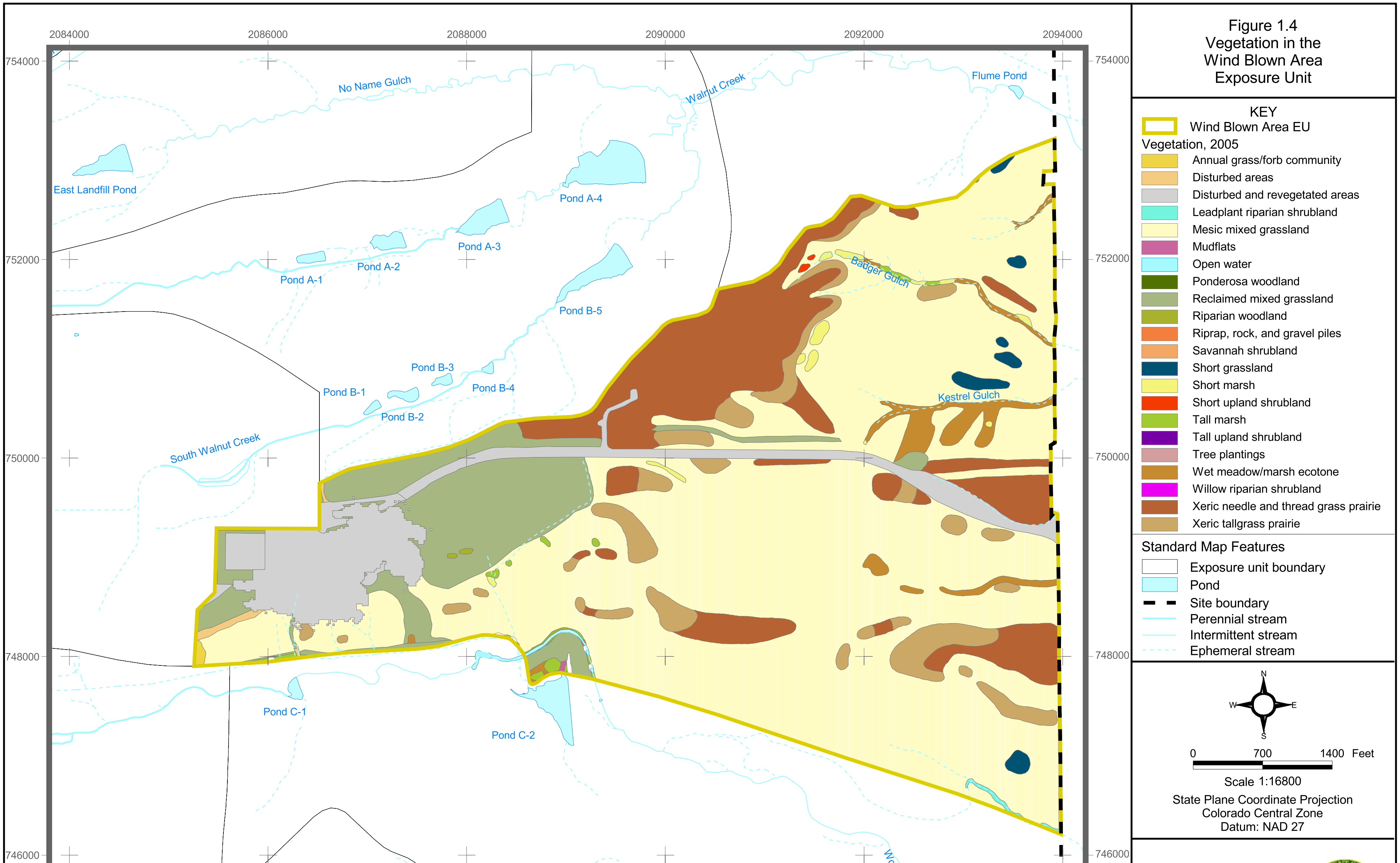


Figure 1.4
Vegetation in the
Wind Blown Area
Exposure Unit

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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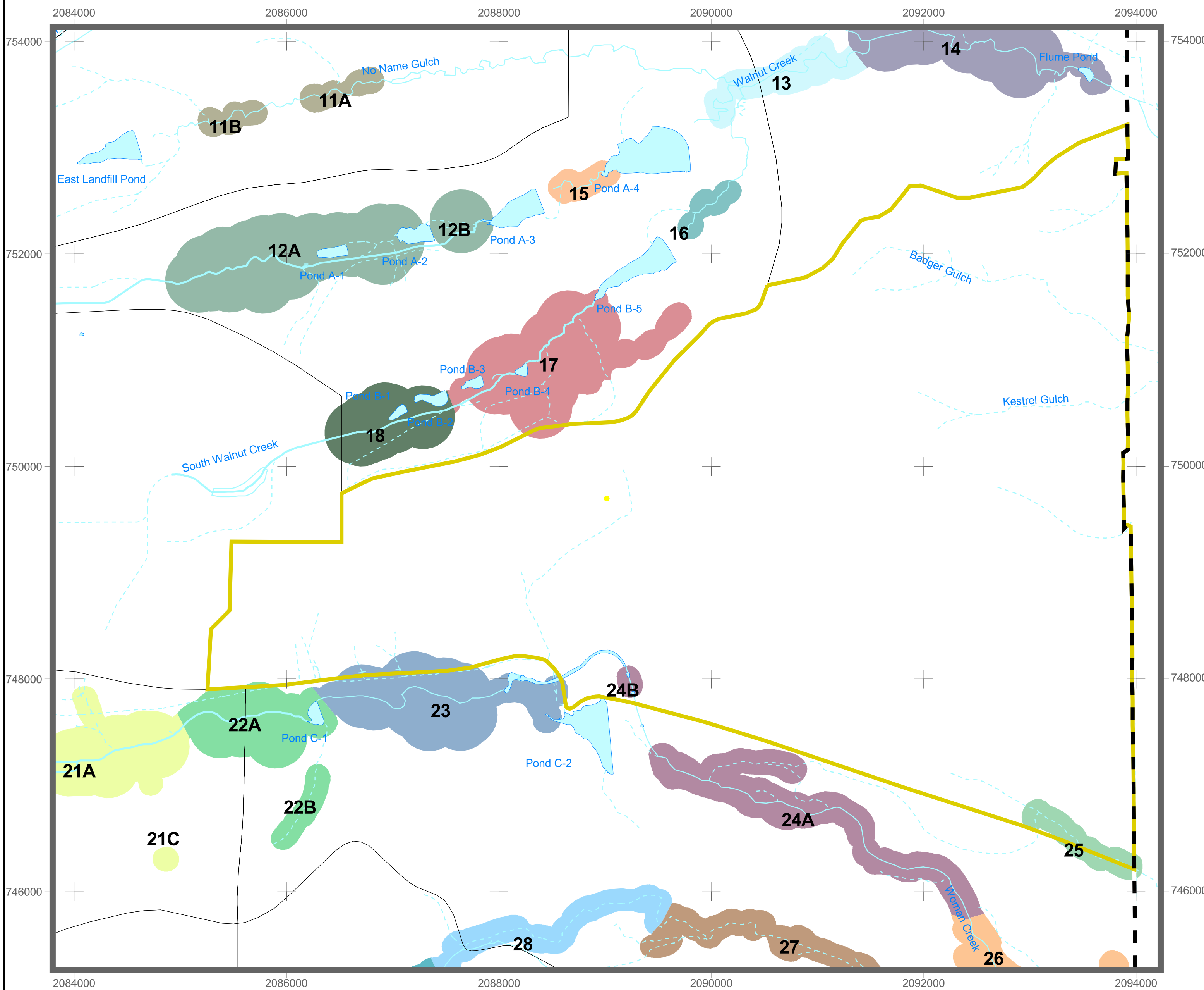


# Figure 1.5
## Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Wind Blown Area Exposure Unit

KEY

- Surface soil sample location
- Wind Blown Area EU
- PMJM habitat patch
- 1 PMJM habitat ID

Note: Not all analyte groups were analyzed at every sample location.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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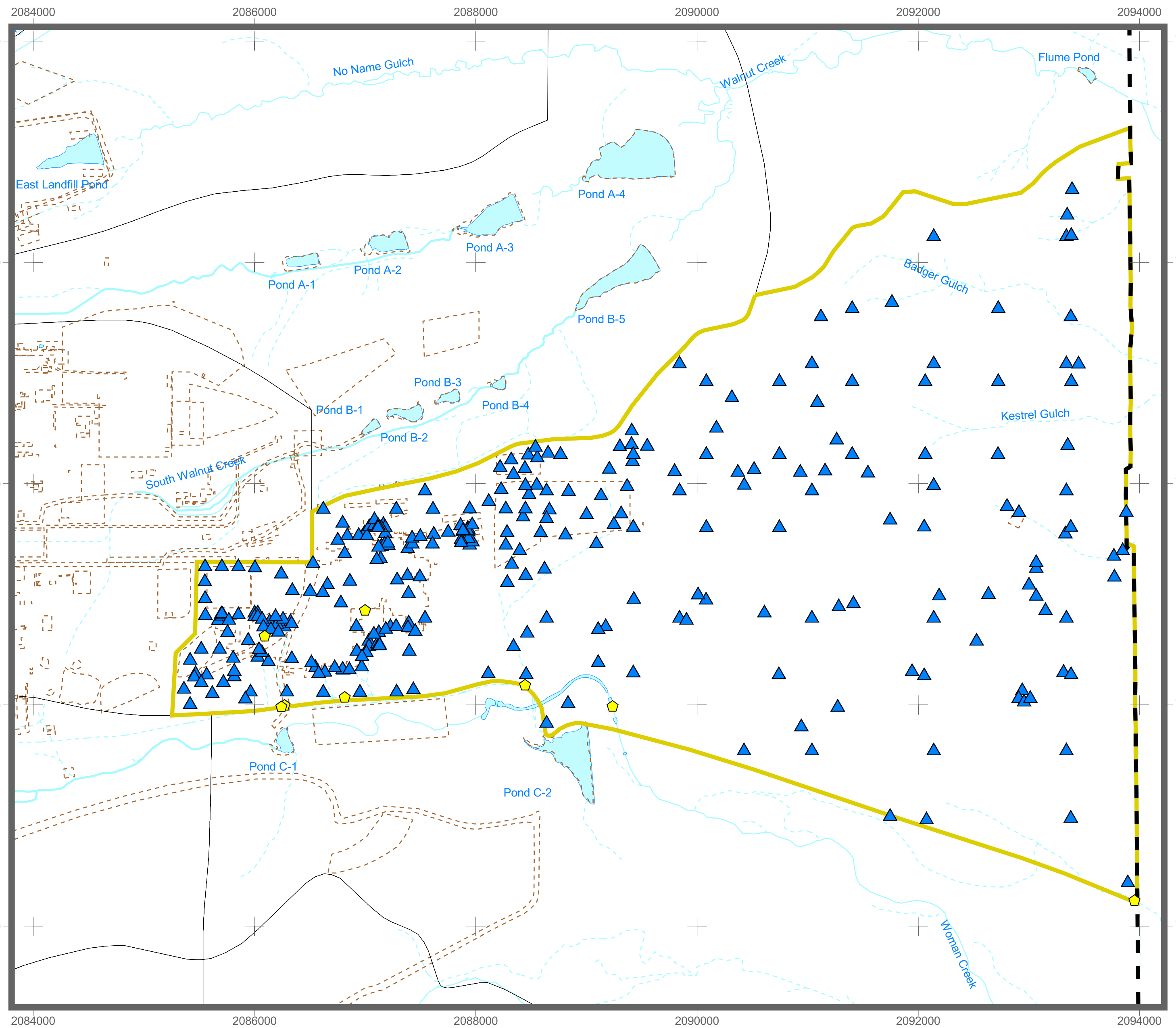


# Figure 1.6
Wind Blown Area Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location
- Surface sediment sample location
- Surface soil sample location
- Wind Blown Area EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
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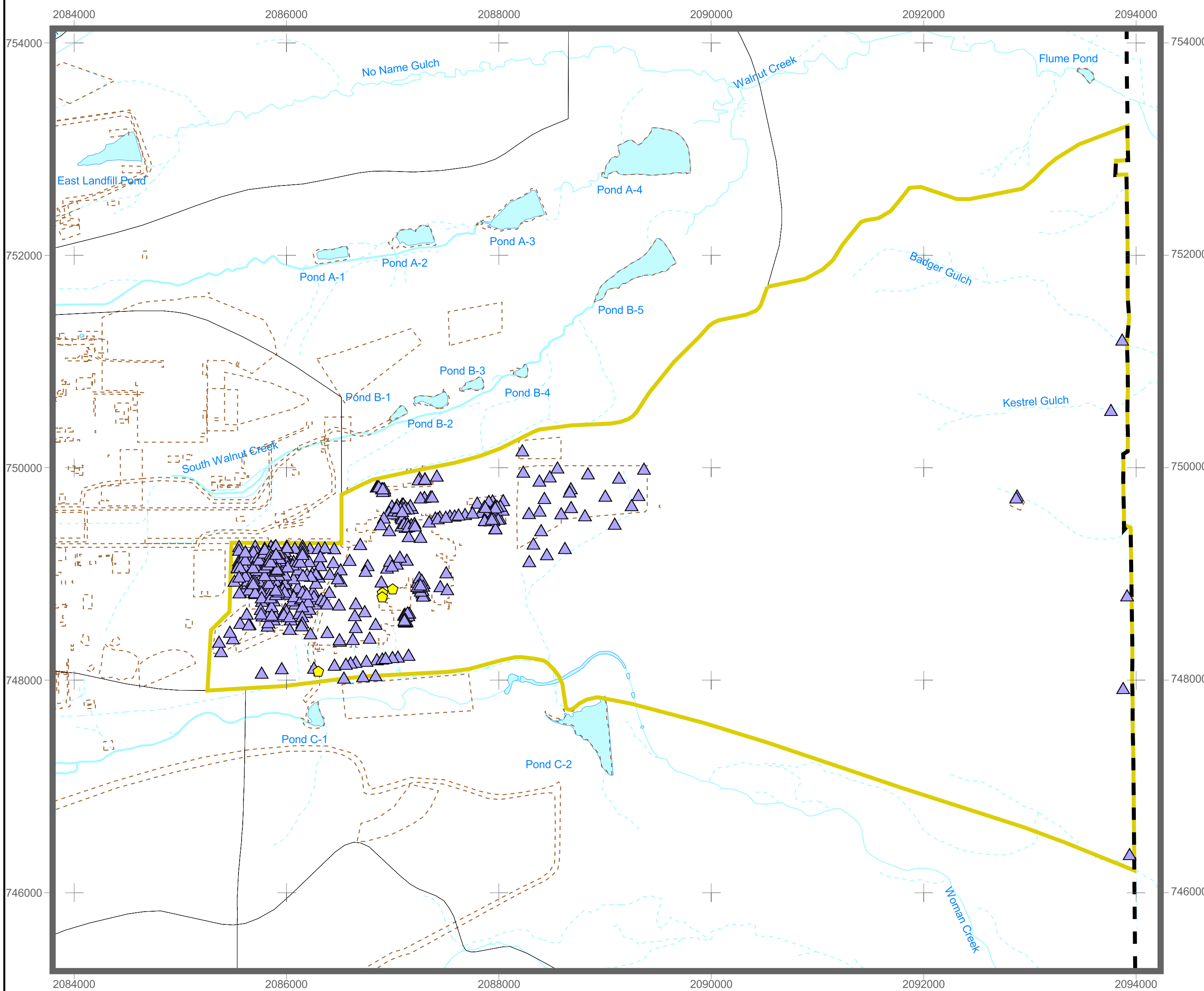
File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\WindBlownArea.apr

Figure 1.7
Wind Blown Area Exposure
Unit Subsurface Soil and Subsurface
Sediment Sample Locations




KEY

Sample location
- Subsurface sediment sample location
- Subsurface soil sample location
- Wind Blown Area EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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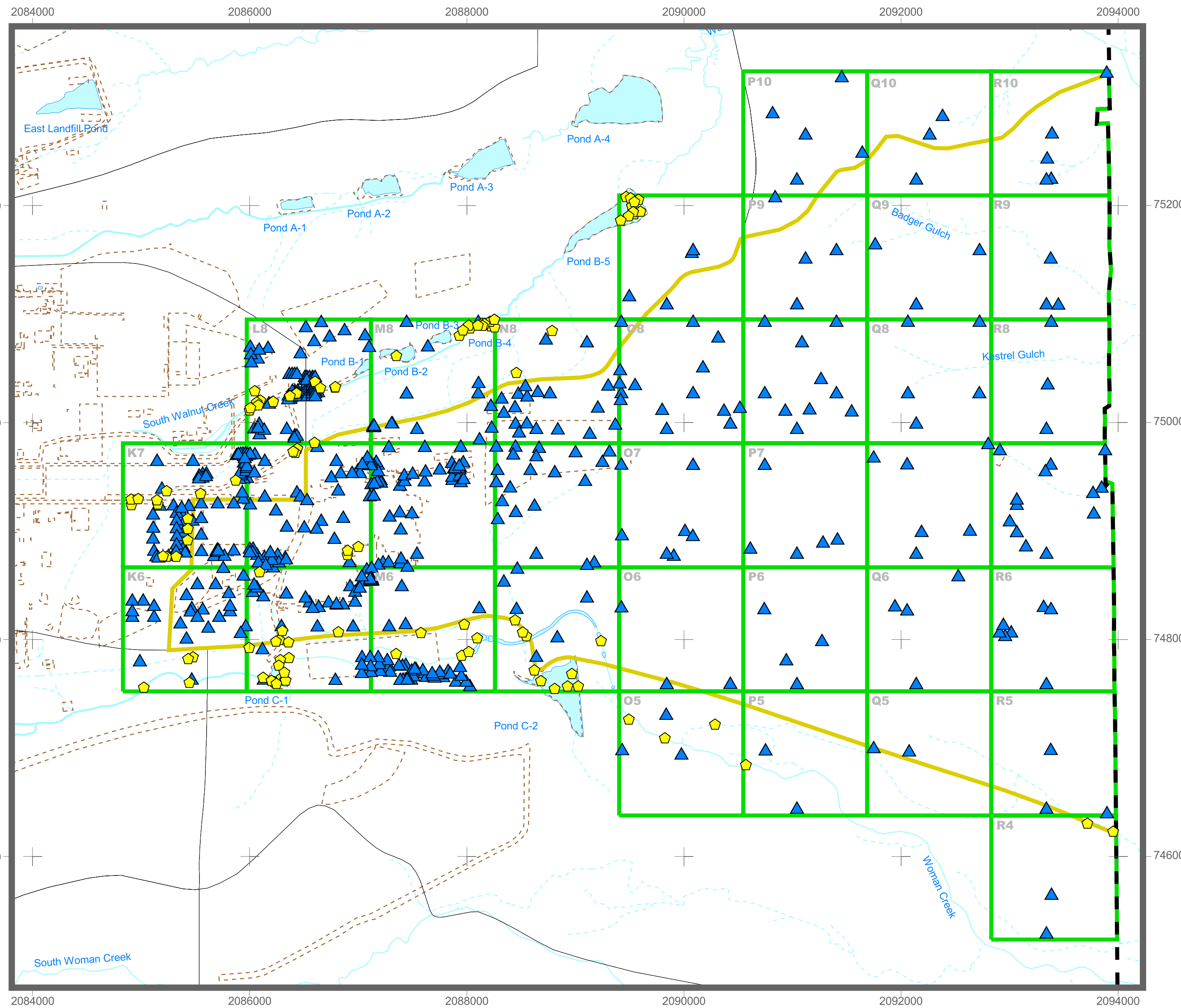
File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\WindBlownArea.apr

Figure 3.1
Tier 2 EPC 30-acre Grids
with Surface Soil and Surface
Sediment Sample Locations




KEY

- Surface sediment sample location
- Surface soil sample location
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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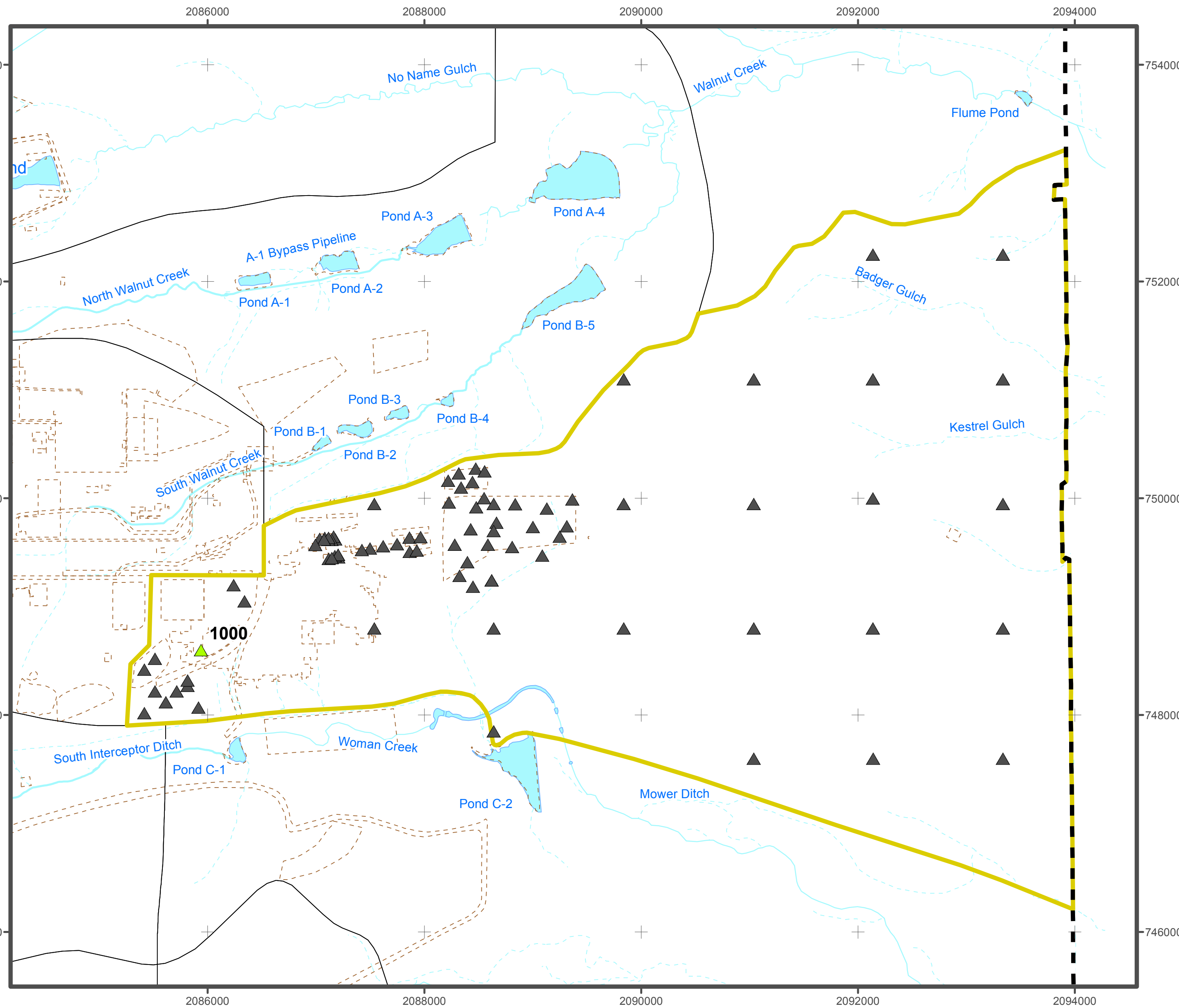


Figure 7.1
Wind Blown Area EU
Surface Soil Results
for Di-n-butylphthalate

KEY

Sample location
Detect
Nondetect
Wind Blown Area EU
Historical IHSS/PAC

**Note:**
Some reported results for nondetects exceed the ESL. See Attachment 1.

CRA Methodology ESL = 16 ug/kg

Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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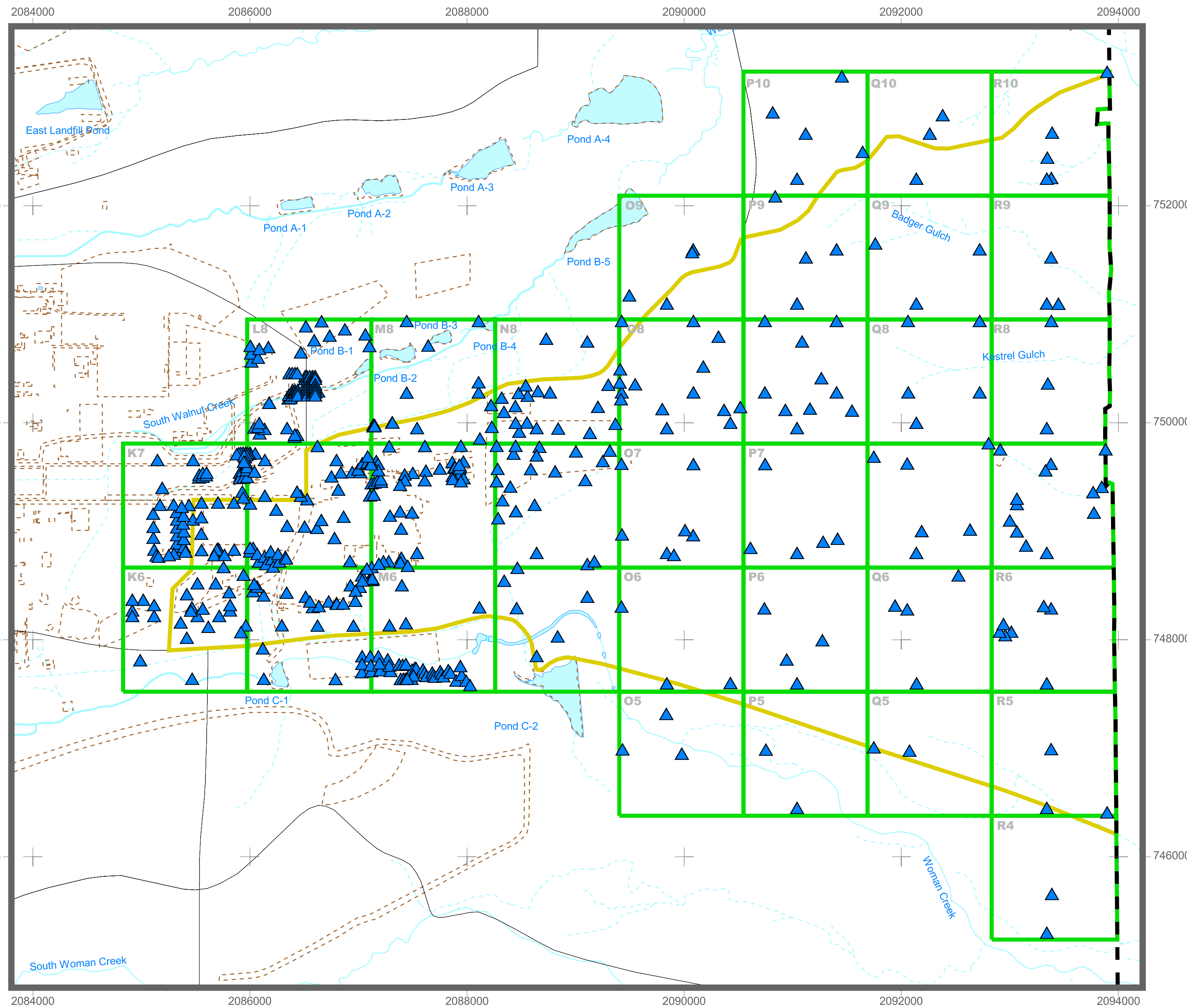


Figure 8.1
Tier 2 EPC 30-acre Grids
with Surface Soil
Sample Locations

KEY

- Surface soil sample location
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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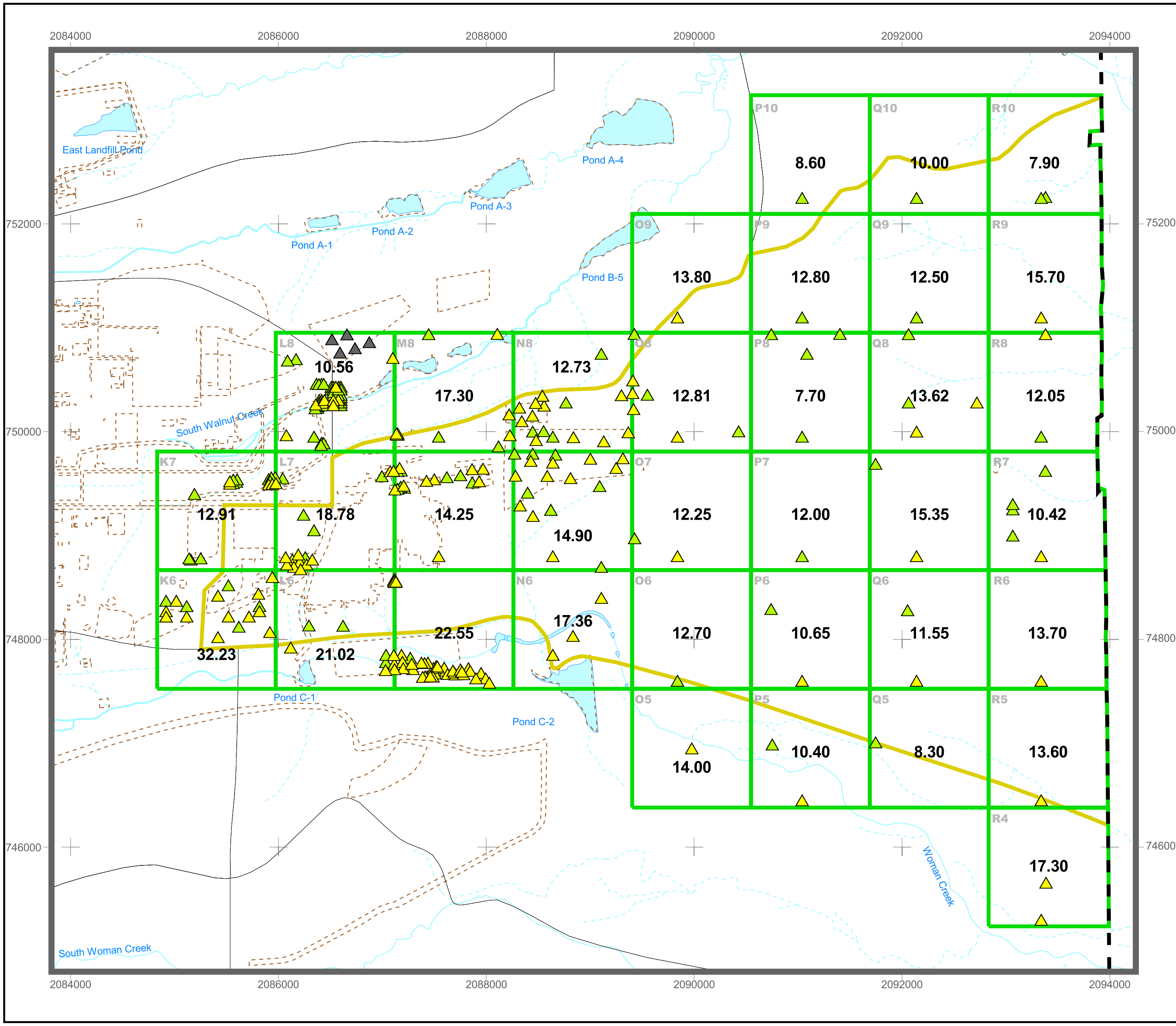


# Figure 10.1
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Chromium

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1.34 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 12.3 mg/kg
Maximum background concentration: 16.9 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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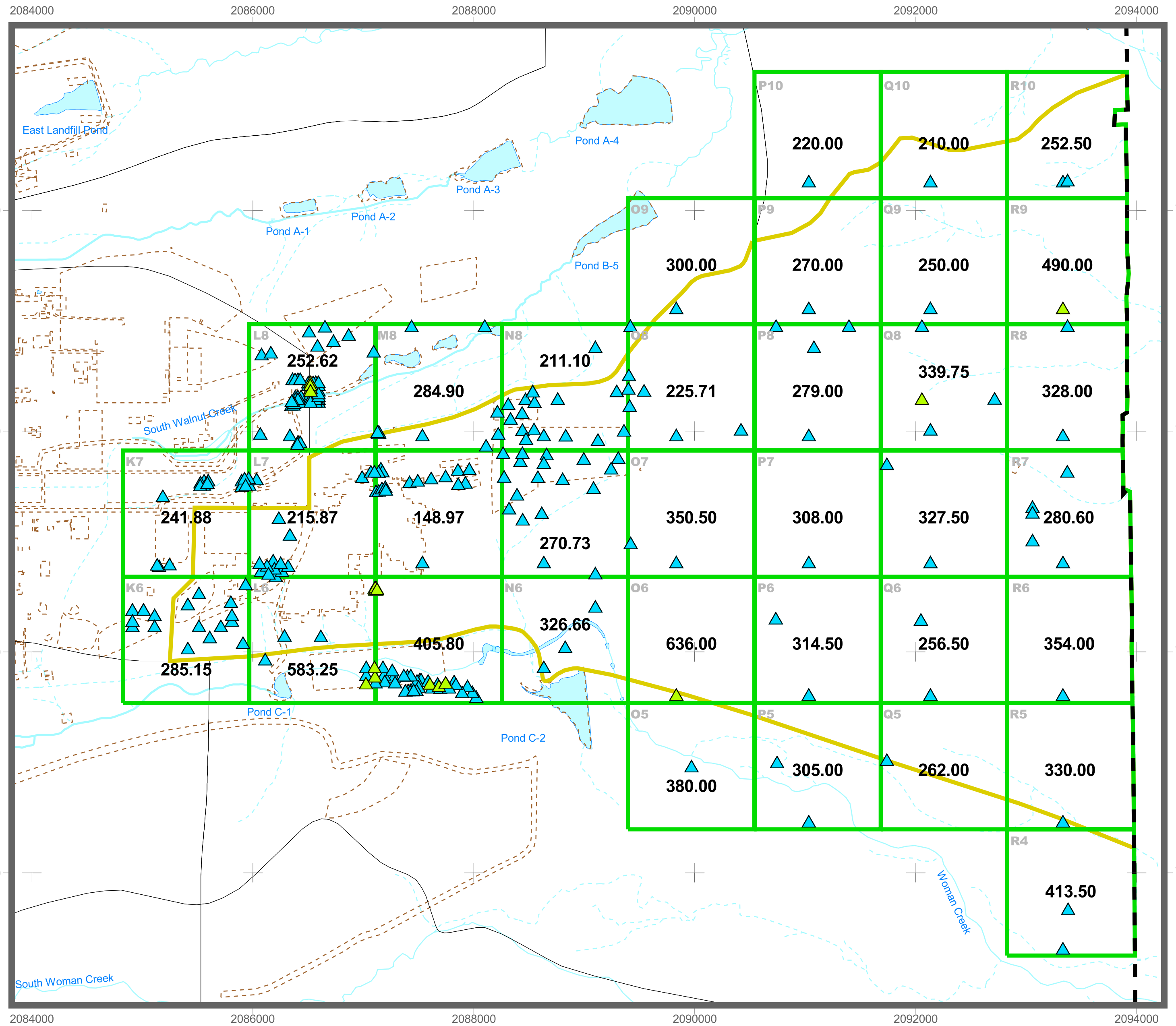
Figure 10.2
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Manganese




## KEY

Surface soil sample location

- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 486 mg/kg
Receptor: Deer Mouse (Herbivore)
95th UCL background: 262 mg/kg
Maximum background concentration: 357 mg/kg

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr

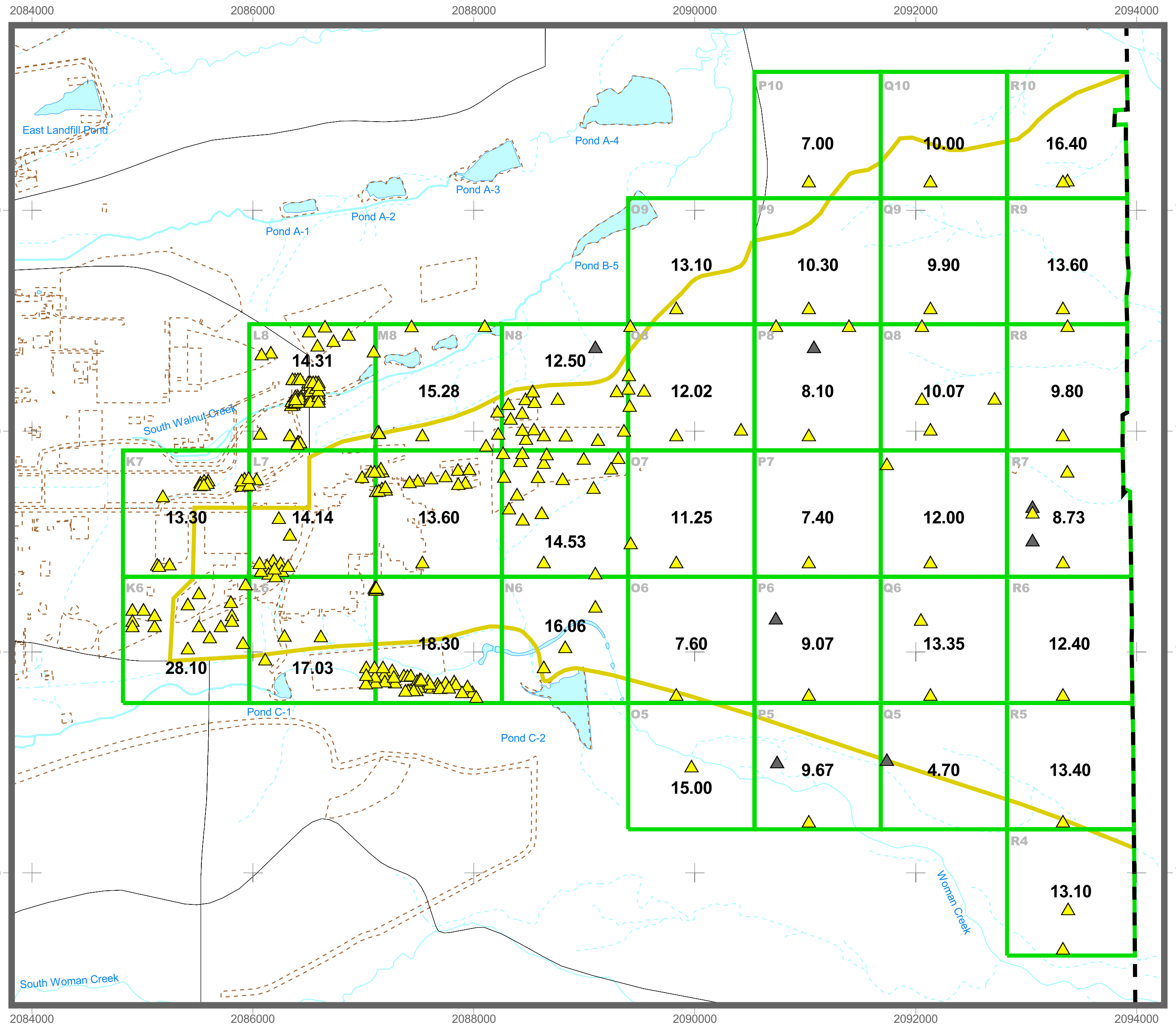


Figure 10.3
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Nickel

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 0.431 mg/kg
Receptor: Deer Mouse (Insectivore)
95th UCL background: 10.6 mg/kg
Maximum background concentration: 14 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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Scale 1:16800
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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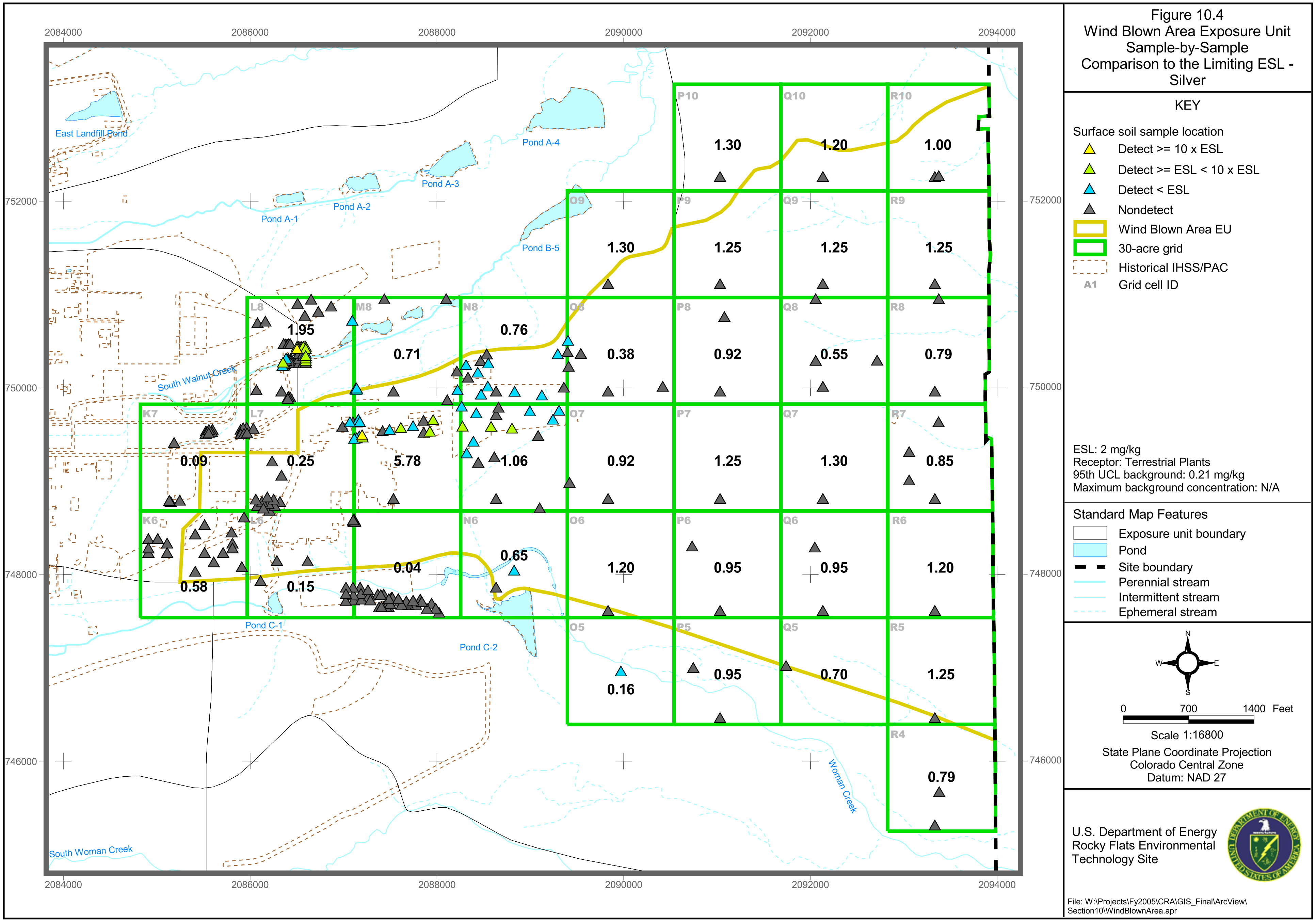
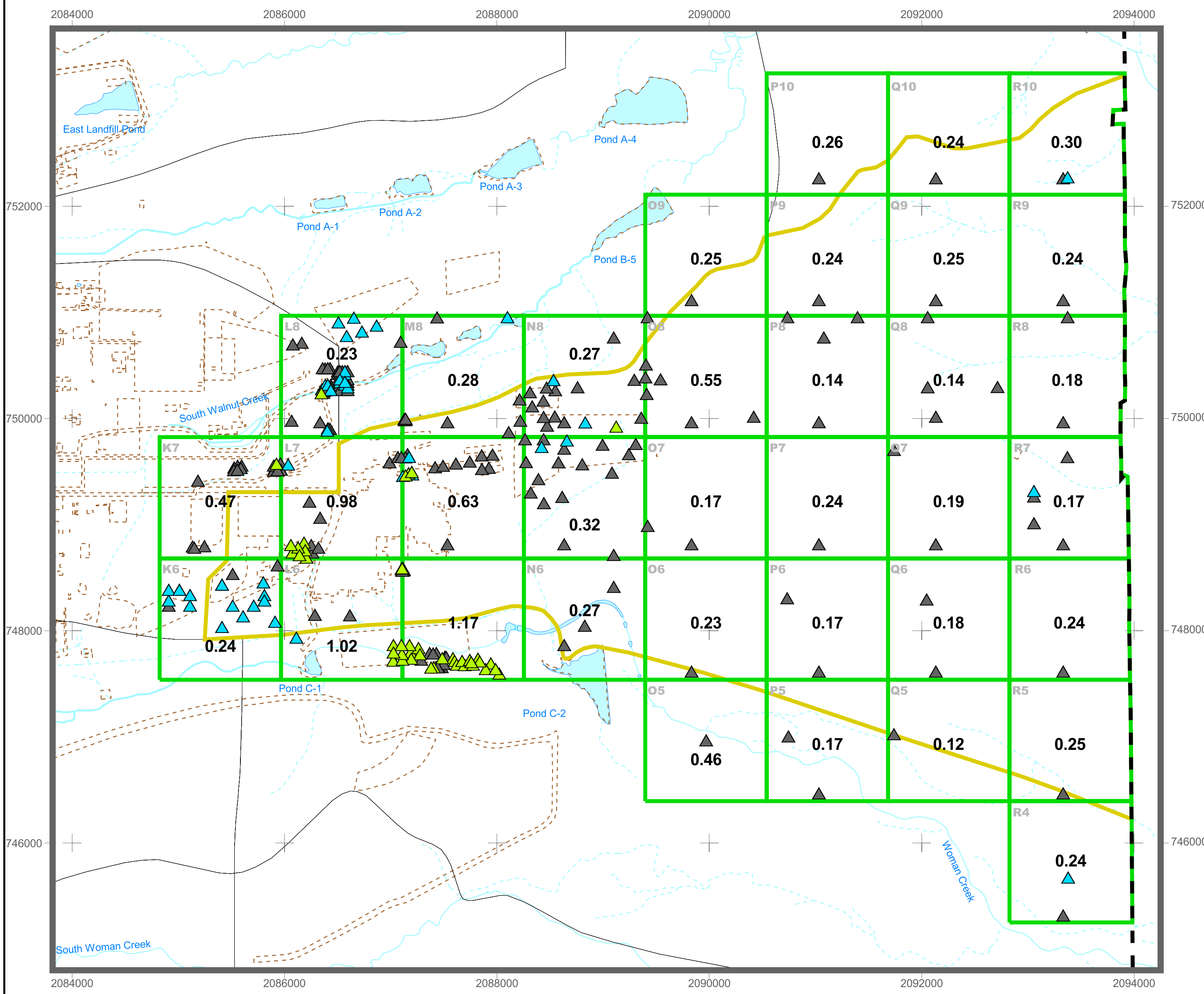



Figure 10.4
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Silver

Figure 10.5
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Thallium




KEY

Surface soil sample location

- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1 mg/kg
Receptor: Terrestrial Plants
95th UCL background: 0.421 mg/kg
Maximum background concentration: N/A

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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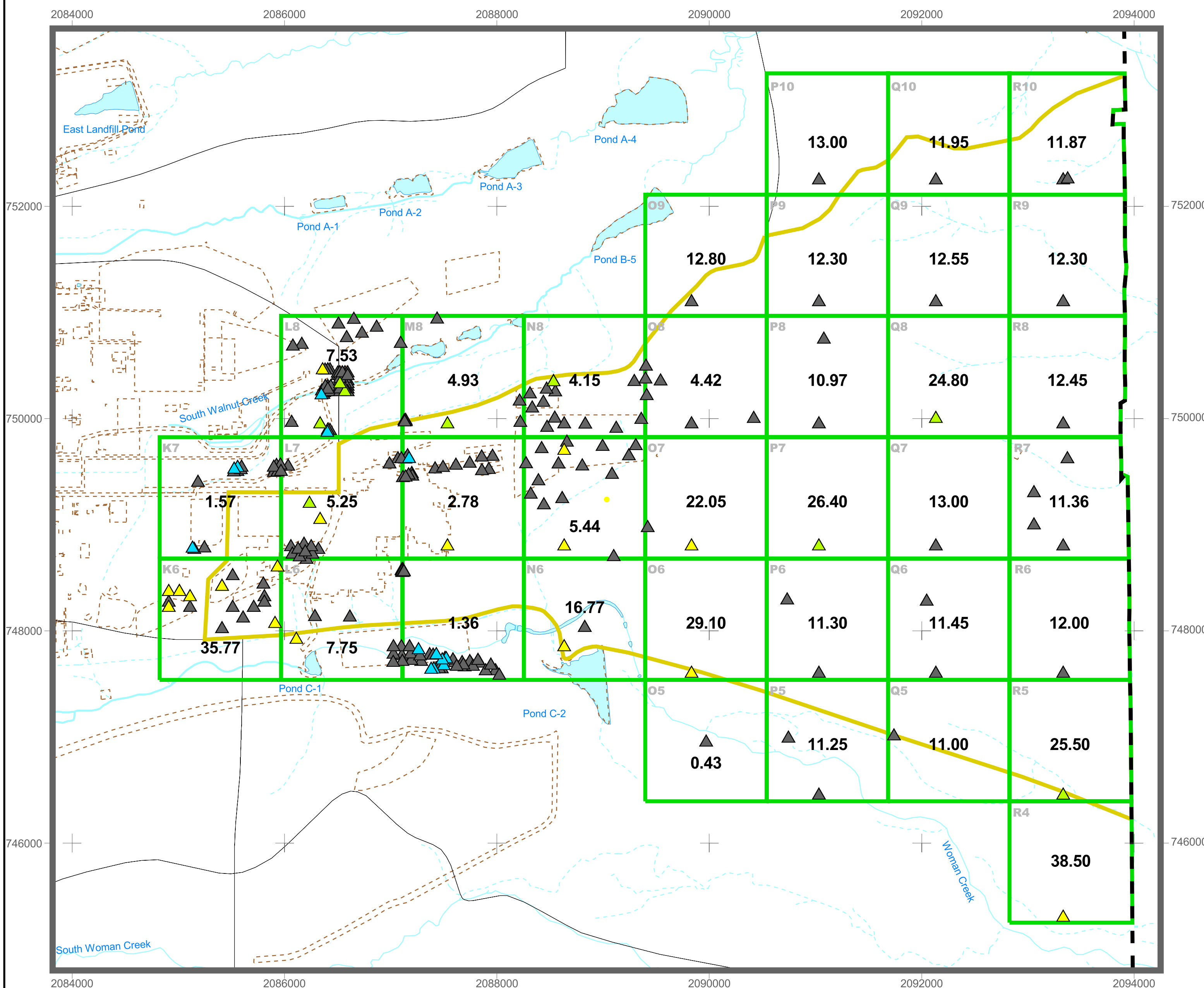
Figure 10.6
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Tin




KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 2.9 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 2.22 mg/kg
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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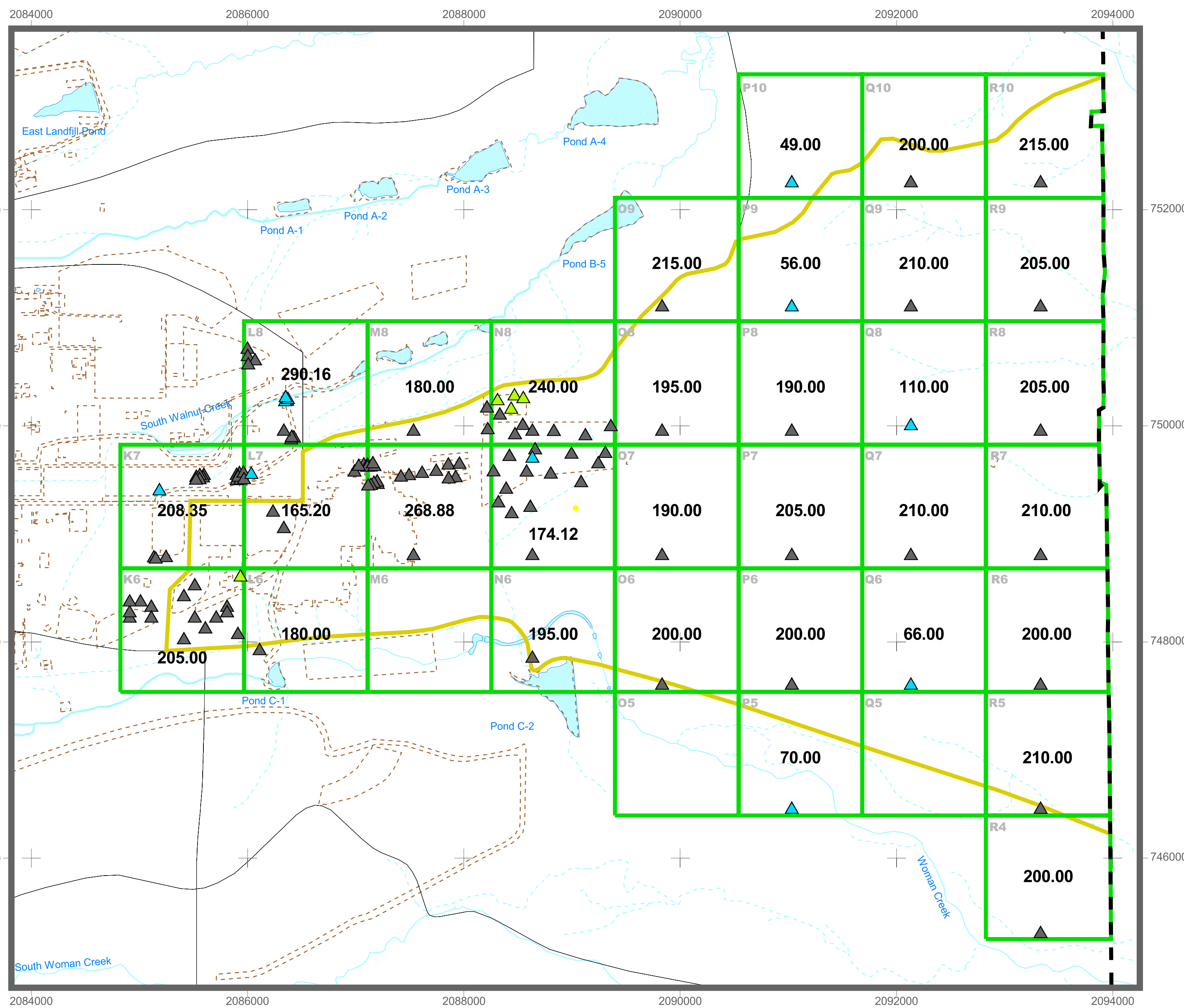


# Figure 10.7
## Wind Blown Area Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Bis(2-ethylhexyl)phthalate

**KEY**

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 137 ug/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: N/A
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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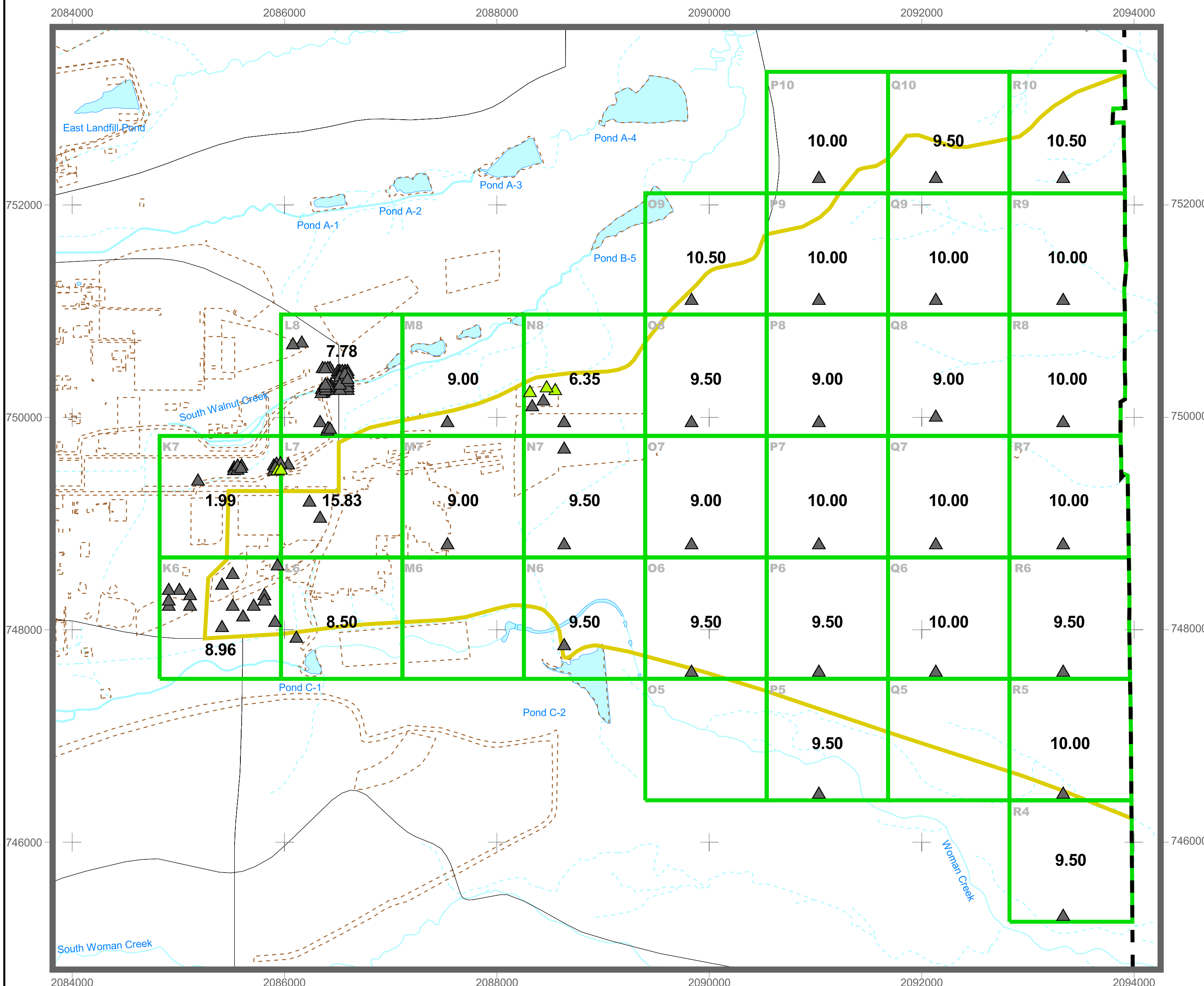
0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr




# Figure 10.8
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Endrin

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1.4 ug/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: N/A
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr

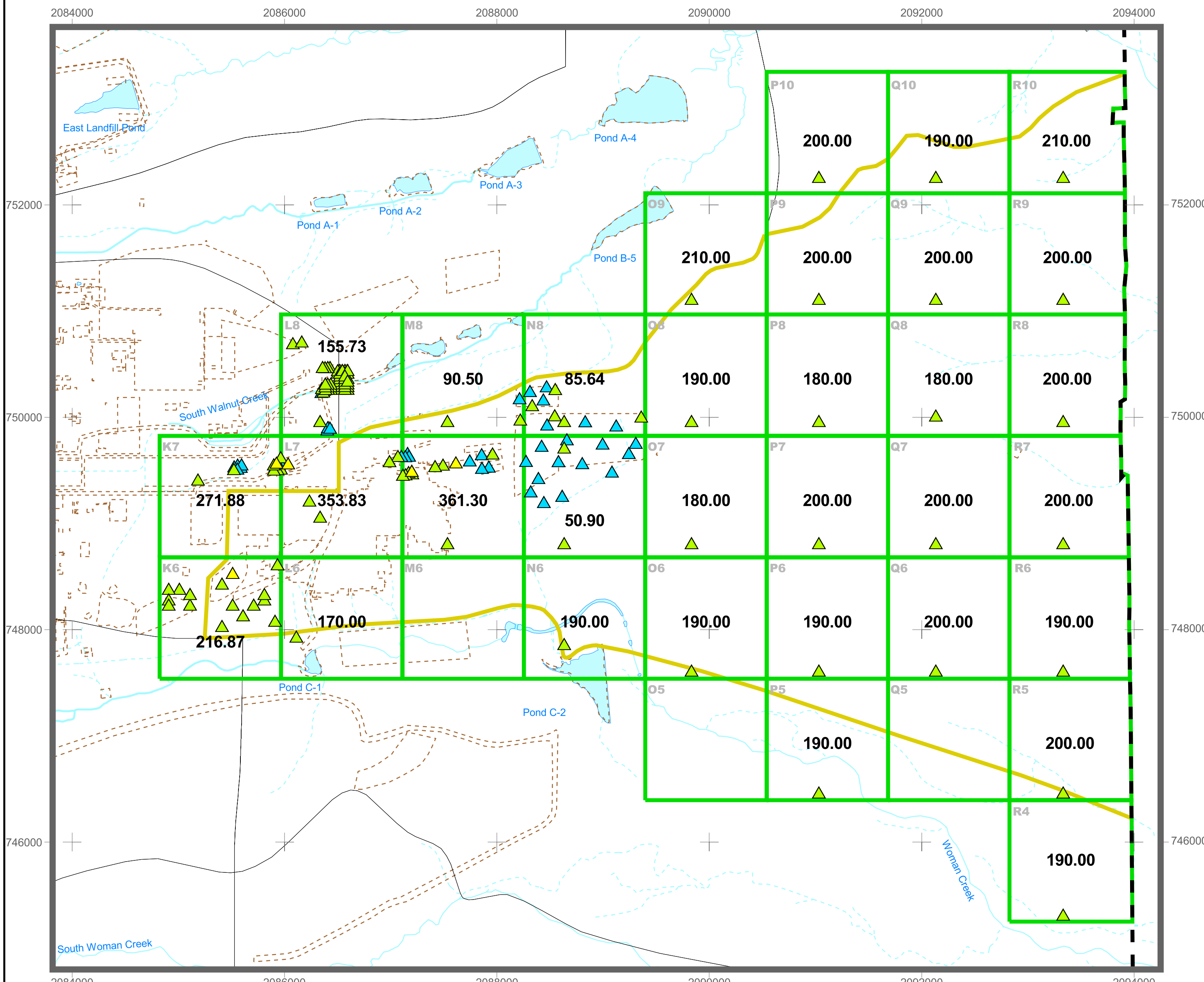


Figure 10.9
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Total PCBs

KEY

Surface soil sample location

- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 42.3 ug/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: N/A
Maximum background concentration: N/A

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr

# COMPREHENSIVE RISK ASSESSMENT

## WIND BLOWN AREA EXPOSURE UNIT

## VOLUME 9: ATTACHMENT 1

## Detection Limit Screen

# TABLE OF CONTENTS



## LIST OF TABLES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| µg/kg | micrograms per kilogram |
| µg/L | micrograms per liter |
| CD | compact disc |
| CRA | Comprehensive Risk Assessment |
| ESL | ecological screening level |
| IHSS | Individual Hazardous Substance Site |
| mg/kg | milligrams per kilogram |
| N/A | not available or not applicable |
| NOAEL | no observed adverse effect level |
| PAC | Potential Area of Concern |
| pCi/g | picocuries per gram |
| PRG | preliminary remediation goal |
| TIC | tentatively identified compound |
| VOC | volatile organic compound |
| WBEU | Wind Blown Area Exposure Unit |
| WRW | wildlife refuge worker |

# 1.0 EVALUATION OF ANALYTE DETECTION LIMITS FOR THE WIND BLOWN AREA EXPOSURE UNIT

For the Wind Blown Area Exposure Unit (EU) (WBEU), the detection limits for non-detected analytes as well as analytes detected in less than 5 percent of the samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW) and the minimum ecological screening levels (ESLs). The comparisons are made in the tables to this attachment for potential contaminants of concern (PCOCs) in surface soil/surface sediment and subsurface soil/subsurface sediment, and ecological contaminants of interest (ECOIs) in surface soil and subsurface soil. The percent of the samples with detection limits that exceed the PRGs and ESLs are listed in these tables. When these detection limits exceed the respective PRGs and ESLs, this is a source of uncertainty in the risk assessment process, which is discussed herein.

Laboratory reported results for “U” qualified data (nondetects) are used to perform the detection limit screen rather than the detection limit identified in the detection limit field within the Soil Water Database (SWD). The basis for the detection limit is not always certain, i.e., Instrument Detection Limit (IDL), Method Detection Limit (MDL), Reporting Limit (RL), Sample Quantitation Limit (SQL), etc. Therefore, to be consistent in reporting, the “reported results” are presented in the tables to this attachment. Also, for statistical computations and risk estimations presented in the main text and tables to this volume, one-half the reported results are used as proxy values for nondetected data.

The term analyte as used in the following sections refers to analytes that are non-detected or detected in less than 5 percent of the samples. PRGs and ESLs do not exist for some of these analytes, which is also a source of uncertainty for the risk assessment. This uncertainty is discussed in Sections 6.2.1 and 10.3.2 of the main text of this volume.

## 1.1 Comparison of Reported Results to Preliminary Remediation Goals

### 1.1.1 Surface Soil/Surface Sediment

As shown in Table A1.1, there are only two analytes in surface soil/surface sediment where the reported results exceed the PRG: dibenz(a,h)anthracene (43.3 percent), and N-nitroso-di-n-propylamine (17.2 percent). In these two cases, most of the reported results are less than the PRGs, and the maximum reported results are approximately within a factor of 2 of the PRGs. Therefore, this represents only minimal uncertainty in the overall risk estimates.

### 1.1.2 Subsurface Soil/Subsurface Sediment

As shown in Table A1.2, there are 17 analytes in subsurface soil/subsurface sediment where some percent of the reported results exceed the PRG. With the exception of N-nitrosodiethylamine and N-nitrosodimethylamine, more than 95 percent of the reported results are less than the PRGs. Consequently, for these analytes, there is minimal uncertainty in the overall risk estimates because of these higher reported results. For N-nitrosodiethylamine and N-nitrosodimethylamine, 100 percent of the reported results exceed the respective PRGs, and in both cases, the maximum reported results are more than an order of magnitude higher than the PRGs. However, these analytes are not expected to be present in WBEU surface soil based on descriptions of potential wastes released at the historical IHSSs in the WBEU, and that they are not identified in the historical inventories of the chemicals at RFETS (CDH 1991). Because the analytes were also not detected anywhere in subsurface soil/subsurface sediment at RFETS, the likelihood that a source area for this chemical at RFETS that would be detected if the reported results were lower is unlikely.

## 1.2 Comparison of Reported Results to Ecological Screening Levels

### 1.2.1 Surface Soil

As shown in Table A1.3, there are 19 analytes in surface soil where some percent of the reported results exceed the lowest ESL. For nine of these analytes, more than 50 percent (and often more than 95 percent) of the reported results are less than the lowest ESL. Consequently, for these analytes, there is minimal uncertainty in the overall risk estimates because of these higher reported results. Of the remaining 10 analytes, 100 percent of the reported results exceed the lowest ESL, and in some cases, the maximum reported results are more than an order of magnitude higher than the lowest ESL. This condition requires further analysis to determine the extent of uncertainty in the overall risk estimates, i.e., ecological risks may be underestimated because these analytes may have been included as ECOPCs had they been detected more frequently using lower detection limits (lower reported results).

First, for these remaining 10 analytes, it is noted that the reported results are generally consistent with industry standards for laboratory detection limits. In all cases, the minimum reported results (see Table A1.3) are similar in magnitude to the Contract Required Quantitation Limits (CRQLs) for the Environmental Protection Agency’s (EPA) Contract Laboratory Program (CLP) (330-830 ug/kg for semi-volatile organic compounds (SVOCs) and 1.7-3.3 ug/kg for pesticides depending on the compound). The CRQLs are minimum limits established by the CLP for identifying contaminants at Superfund sites.

Even though the lower limit of the range of reported results are generally consistent with industry standards for laboratory detection limits, the extent of uncertainty in the overall risk estimates was further assessed based on professional judgment and ecological risk potential.

Professional judgment indicates whether the analytes are likely to be ECOPCs in the WBEU surface soil based on 1) a listing of the analytes (or classes of analytes) as constituents in wastes potentially released at historical Individual Hazardous Substance Sites (IHSSs) in the WBEU (DOE 2005a), 2) the historical inventory for the chemical at RFETS (CDH 1991), and 3) a comparison of the maximum detected concentration and detection frequency in the EU and sitewide surface soil (see Table A1.4 for sitewide surface soil summary statistics). The comparison of the EU and sitewide maximum detected concentrations and detection frequencies in surface soil is performed to assess if the EU observations are much higher, which may potentially also indicate a source for the analyte within the EU. Using professional judgment, the analytes can be grouped into four categories that represent an ascending order of uncertainty. Category 1 is for analytes that were not listed as waste constituents for the EU historical IHSSs, and are not detected in the EU or sitewide surface soil. Category 2 is for analytes that may or may not be listed as waste constituents for the EU historical IHSSs, but nevertheless are not detected in the EU surface soil even though they were detected in other EU surface soil at RFETS at low maximum detected concentrations and low detection frequencies. Category 3 is for analytes that may or may not be listed as waste constituents for the EU historical IHSSs, and are detected in the EU (and therefore sitewide) surface soil, and the maximum detected concentrations in the EU surface soil are approximately the same order of magnitude as the ESL, and the detection frequencies are low. For these first three categories, the uncertainty with regard to the risk estimates because of the higher detection limits is considered small. Category 4 is for analytes that are detected in the EU (and therefore sitewide) surface soil at maximum concentrations that substantially exceed the ESLs and at detection frequencies generally higher than for Category 3, i.e., these analytes have the highest likelihood of being ECOPCs had they been detected more frequently using lower detection limits (lower reported results), and therefore, there is some uncertainty with regard to the risk estimates because of the higher detection limits.

The assessment of the ecological risk potential compares the maximum reported result to a Lowest Observed Adverse Effect Level (LOAEL)-based soil concentration. ESLs are based on No Observed Adverse Effect Levels (NOAELs) (DOE 2005b). The LOAEL-based soil concentration is estimated by multiplying the lowest ESL by the LOAEL/NOAEL ratio for the mammal or the bird depending on whether a mammal or bird is the most sensitive terrestrial vertebrate receptor for the chemical (see Appendix B, Table B-2 of the Final CRA Work Plan and Methodology, Revision 1 (DOE 2005b) for the Lowest Bounded LOAELs and Final NOAELs for mammals and birds). A maximum reported result/LOAEL-based soil concentration ratio greater than one indicates a potential for an adverse ecological effect if the analyte was detected at the highest reported result.

As shown in Table A1.5, 9 of the 10 analytes assessed using professional judgment are in categories 1 through 3 (mostly categories 1 and 2), and thus are not likely to be ECOPCs in the WBEU surface soil based on professional judgment, which minimizes the uncertainty in the overall risk estimates because of their higher reported results. Di-n-butylphthalate is the only category 4 analyte, i.e., it has potential to be an ECOPC in the WBEU surface soil based on professional judgment.

Comparing the maximum reported results to the LOAEL-based soil concentrations indicates less than half of the above noted analytes would present a potential for adverse ecological effects if they were detected at the maximum reported results; however, this includes di-n-butylphthalate.

In conclusion, with the exception of di-n-butylphthalate, analytes in surface soil that have reported results that exceed the lowest ESLs contribute a low level of uncertainty to the overall risk estimates because either only a small fraction of the reported results are greater than the lowest ESL, or professional judgment indicate they are not likely to be ECOPCs in surface soil even if detection limits (reported results) had been lower. Di-n-butylphthalate also has a potential for adverse ecological effects had it been detected at the maximum reported result. Therefore, there is some uncertainty in the overall risk estimates associated with the high reported results for di-n-butylphthalate, i.e., ecological risks may be underestimated because this analyte may have been included as an ECOPC had it been detected more frequently using lower detection limits (lower reported results).

### 1.2.2 Subsurface Soil

As shown in Table A1.6, there are nine analytes in subsurface soil where some percent of the reported results exceed the prairie dog ESL. However, more than 95 percent of the reported results are less than the lowest ESL. Consequently, for these analytes, there is minimal uncertainty in the overall risk estimates because of these higher reported results.

## 2.0 REFERENCES

CDH, 1991. Colorado Department of Health Project Task 1 Report (Revised 1), Identification of Chemicals and Radionuclides Used at Rocky Flats. Prepared by ChemRisk. March.

DOE, 2005a, 2005 Annual Update to the Historical Release Report, Rocky Flats Environmental Technology Site, October.

DOE, 2005b. Final Comprehensive Risk Assessment Work Plan and Methodology, Revision 1, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

# TABLES

**Table A1.1**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | PRG | Number of Nondetected Results > PRG | Percent Nondetected Results > PRG | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| **Inorganic (mg/kg)** | | | | | | | | |
| Chromium VI | 0.960 | - | 1.20 | 4 | 28.4 | 0 | 0 | No |
| **Organic (ug/kg)** | | | | | | | | |
| 1,1,1,2-Tetrachloroethane | 1.15 | - | 1.30 | 13 | 91,018 | 0 | 0 | No |
| 1,1,1-Trichloroethane | 1.02 | - | 12 | 21 | 9.18E+06 | 0 | 0 | No |
| 1,1,2,2-Tetrachloroethane | 0.899 | - | 12 | 20 | 10,483 | 0 | 0 | Yes |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.911 | - | 1.03 | 13 | 2.38E+09 | 0 | 0 | No |
| 1,1,2-Trichloroethane | 0.865 | - | 12 | 21 | 28,022 | 0 | 0 | No |
| 1,1-Dichloroethane | 0.918 | - | 12 | 21 | 2.72E+06 | 0 | 0 | No |
| 1,1-Dichloroethene | 1.38 | - | 12 | 21 | 17,366 | 0 | 0 | No |
| 1,1-Dichloropropene | 1.17 | - | 1.33 | 13 | | 0 | 0 | No |
| 1,2,3-Trichlorobenzene | 0.653 | - | 0.739 | 13 | | 0 | 0 | No |
| 1,2,4-Trichlorobenzene | 0.904 | - | 820 | 107 | 151,360 | 0 | 0 | No |
| 1,2-Dibromo-3-chloropropane | 1.68 | - | 1.90 | 13 | 2,968 | 0 | 0 | No |
| 1,2-Dibromoethane | 0.766 | - | 0.867 | 13 | 35.1 | 0 | 0 | No |
| 1,2-Dichlorobenzene | 0.682 | - | 780 | 99 | 2.89E+06 | 0 | 0 | No |
| 1,2-Dichloroethane | 0.930 | - | 12 | 21 | 13,270 | 0 | 0 | No |
| 1,2-Dichloroethene | 5 | - | 12 | 8 | 999,783 | 0 | 0 | No |
| 1,2-Dichloropropane | 0.799 | - | 12 | 21 | 38,427 | 0 | 0 | No |
| 1,3,5-Trimethylbenzene | 0.908 | - | 1.03 | 13 | 114,340 | 0 | 0 | No |
| 1,3-Dichlorobenzene | 0.951 | - | 820 | 107 | 3.33E+06 | 0 | 0 | No |
| 1,3-Dichloropropane | 0.540 | - | 0.612 | 13 | | 0 | 0 | No |
| 1,4-Dichlorobenzene | 1.03 | - | 780 | 99 | 91,315 | 0 | 0 | No |
| 2,2-Dichloropropane | 0.945 | - | 1.07 | 13 | | 0 | 0 | No |
| 2,4,5-Trichlorophenol | 340 | - | 3,900 | 89 | 8.01E+06 | 0 | 0 | No |
| 2,4,6-Trichlorophenol | 340 | - | 820 | 89 | 272,055 | 0 | 0 | No |
| 2,4-Dichlorophenol | 340 | - | 820 | 89 | 240,431 | 0 | 0 | No |
| 2,4-Dimethylphenol | 340 | - | 820 | 89 | 1.60E+06 | 0 | 0 | No |
| 2,4-Dinitrophenol | 1,600 | - | 4,100 | 88 | 160,287 | 0 | 0 | No |
| 2,4-Dinitrotoluene | 340 | - | 820 | 94 | 160,287 | 0 | 0 | No |
| 2,6-Dinitrotoluene | 340 | - | 820 | 94 | 80,144 | 0 | 0 | No |
| 2-Butanone | 9.29 | - | 24 | 20 | 4.64E+07 | 0 | 0 | Yes |
| 2-Chloronaphthalene | 340 | - | 820 | 94 | 6.41E+06 | 0 | 0 | No |
| 2-Chlorophenol | 340 | - | 820 | 89 | 555,435 | 0 | 0 | No |
| 2-Chlorotoluene | 1.47 | - | 1.66 | 13 | 2.22E+06 | 0 | 0 | No |
| 2-Hexanone | 7.44 | - | 24 | 21 | | 0 | 0 | No |
| 2-Methylnaphthalene | 340 | - | 820 | 94 | 320,574 | 0 | 0 | No |
| 2-Methylphenol | 340 | - | 820 | 89 | 4.01E+06 | 0 | 0 | No |
| 2-Nitroaniline | 1,600 | - | 4,100 | 94 | 192,137 | 0 | 0 | No |
| 2-Nitrophenol | 340 | - | 820 | 89 | | 0 | 0 | No |
| 3,3'-Dichlorobenzidine | 670 | - | 1,600 | 94 | 6,667 | 0 | 0 | No |
| 3-Nitroaniline | 1,600 | - | 4,100 | 91 | | 0 | 0 | No |
| 4,4'-DDD | 9.10 | - | 38 | 49 | 15,528 | 0 | 0 | No |
| 4,4'-DDT | 9.10 | - | 38 | 49 | 10,927 | 0 | 0 | No |
| 4,6-Dinitro-2-methylphenol | 1,600 | - | 4,100 | 87 | 8,014 | 0 | 0 | Yes |
| 4-Bromophenyl-phenylether | 340 | - | 820 | 94 | | 0 | 0 | No |
| 4-Chloro-3-methylphenol | 340 | - | 1,600 | 89 | | 0 | 0 | No |
| 4-Chloroaniline | 340 | - | 1,600 | 94 | 320,574 | 0 | 0 | No |
| 4-Chlorophenyl-phenyl ether | 340 | - | 820 | 94 | | 0 | 0 | No |
| 4-Chlorotoluene | 0.861 | - | 0.975 | 13 | | 0 | 0 | No |
| 4-Isopropyltoluene | 1.01 | - | 1.15 | 13 | | 0 | 0 | No |
| 4-Methyl-2-pentanone | 6.29 | - | 24 | 21 | 8.32E+07 | 0 | 0 | No |
| 4-Methylphenol | 340 | - | 820 | 89 | 400,718 | 0 | 0 | No |

**Table A1.1**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | PRG | Number of Nondetected Results > PRG | Percent Nondetected Results > PRG | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| 4-Nitroaniline | 1,600 | - | 4,100 | 93 | 207,917 | 0 | 0 | No |
| 4-Nitrophenol | 1,600 | - | 4,100 | 89 | 641,148 | 0 | 0 | No |
| Acenaphthylene | 340 | - | 780 | 94 | | 0 | 0 | No |
| Aldrin | 8.10 | - | 19 | 48 | 176 | 0 | 0 | Yes |
| alpha-BHC | 8.10 | - | 19 | 49 | 570 | 0 | 0 | No |
| alpha-Chlordane | 80 | - | 190 | 44 | 10,261 | 0 | 0 | Yes |
| Benzene | 0.759 | - | 12 | 20 | 23,563 | 0 | 0 | Yes |
| Benzyl Alcohol | 340 | - | 1,600 | 89 | 2.40E+07 | 0 | 0 | No |
| beta-BHC | 8.10 | - | 19 | 48 | 1,995 | 0 | 0 | Yes |
| beta-Chlordane | 81 | - | 190 | 39 | 10,261 | 0 | 0 | No |
| bis(2-Chloroethoxy) methane | 340 | - | 820 | 94 | | 0 | 0 | No |
| bis(2-Chloroethyl) ether | 340 | - | 820 | 94 | 3,767 | 0 | 0 | No |
| bis(2-Chloroisopropyl) ether | 340 | - | 820 | 93 | 59,301 | 0 | 0 | No |
| Bromobenzene | 1.02 | - | 1.15 | 13 | | 0 | 0 | No |
| Bromochloromethane | 1.08 | - | 1.23 | 13 | | 0 | 0 | No |
| Bromodichloromethane | 0.637 | - | 12 | 21 | 67,070 | 0 | 0 | No |
| Bromoform | 1.03 | - | 12 | 21 | 419,858 | 0 | 0 | No |
| Bromomethane | 1.48 | - | 24 | 21 | 20,959 | 0 | 0 | No |
| Butylbenzylphthalate | 340 | - | 820 | 94 | 1.60E+07 | 0 | 0 | No |
| Carbon Disulfide | 2.57 | - | 12 | 21 | 1.64E+06 | 0 | 0 | No |
| Carbon Tetrachloride | 1.09 | - | 12 | 21 | 8,446 | 0 | 0 | No |
| Chlordane | 91 | - | 98 | 4 | 10,261 | 0 | 0 | No |
| Chlorobenzene | 0.918 | - | 12 | 20 | 666,523 | 0 | 0 | Yes |
| Chloroethane | 3.62 | - | 24 | 21 | 1.43E+06 | 0 | 0 | No |
| Chloroform | 0.830 | - | 12 | 21 | 7,850 | 0 | 0 | No |
| Chloromethane | 1.30 | - | 24 | 20 | 115,077 | 0 | 0 | No |
| cis-1,2-Dichloroethene | 0.984 | - | 1.11 | 13 | 1.11E+06 | 0 | 0 | No |
| cis-1,3-Dichloropropene | 0.810 | - | 12 | 21 | 19,432 | 0 | 0 | No |
| delta-BHC | 8.10 | - | 19 | 48 | 570 | 0 | 0 | Yes |
| Dibenz(a,h)anthracene | 340 | - | 820 | 90 | 379 | 39 | 43.3 | Yes |
| Dibenzofuran | 340 | - | 820 | 92 | 222,174 | 0 | 0 | Yes |
| Dibromochloromethane | 0.676 | - | 12 | 21 | 49,504 | 0 | 0 | No |
| Dibromomethane | 0.706 | - | 0.799 | 13 | | 0 | 0 | No |
| Dichlorodifluoromethane | 1.76 | - | 2.00 | 13 | 229,820 | 0 | 0 | No |
| Dieldrin | 9.10 | - | 47 | 47 | 187 | 0 | 0 | Yes |
| Diethylphthalate | 340 | - | 840 | 94 | 6.41E+07 | 0 | 0 | No |
| Dimethylphthalate | 340 | - | 820 | 94 | 8.01E+08 | 0 | 0 | No |
| Di-n-octylphthalate | 340 | - | 820 | 93 | 3.21E+06 | 0 | 0 | Yes |
| Endosulfan I | 8.10 | - | 19 | 48 | 480,861 | 0 | 0 | Yes |
| Endosulfan II | 9.10 | - | 38 | 49 | 480,861 | 0 | 0 | No |
| Endosulfan sulfate | 9.10 | - | 38 | 49 | 480,861 | 0 | 0 | No |
| Endrin aldehyde | 9.10 | - | 9.80 | 4 | 24,043 | 0 | 0 | No |
| Endrin ketone | 16 | - | 38 | 45 | 33,326 | 0 | 0 | No |
| Ethylbenzene | 0.987 | - | 12 | 20 | 5.39E+06 | 0 | 0 | Yes |
| Fluorene | 340 | - | 820 | 90 | 3.21E+06 | 0 | 0 | Yes |
| gamma-BHC (Lindane) | 8.10 | - | 19 | 49 | 2,771 | 0 | 0 | No |
| Heptachlor | 8.10 | - | 19 | 48 | 665 | 0 | 0 | Yes |
| Heptachlor epoxide | 8.10 | - | 38 | 48 | 329 | 0 | 0 | Yes |
| Hexachlorobenzene | 340 | - | 820 | 94 | 1,870 | 0 | 0 | No |
| Hexachlorobutadiene | 1.15 | - | 820 | 107 | 22,217 | 0 | 0 | No |
| Hexachlorocyclopentadiene | 340 | - | 840 | 94 | 380,452 | 0 | 0 | No |
| Hexachloroethane | 340 | - | 820 | 94 | 111,087 | 0 | 0 | No |
| Isophorone | 340 | - | 820 | 94 | 3.16E+06 | 0 | 0 | No |

**Table A1.1**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | PRG | Number of Nondetected Results > PRG | Percent Nondetected Results > PRG | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| Isopropylbenzene | 1.20 | - | 1.36 | 13 | 32,680 | 0 | 0 | No |
| Naphthalene | 0.765 | - | 820 | 106 | 1.40E+06 | 0 | 0 | Yes |
| n-Butylbenzene | 0.958 | - | 1.08 | 13 | | 0 | 0 | No |
| Nitrobenzene | 340 | - | 820 | 89 | 43,246 | 0 | 0 | No |
| N-Nitroso-di-n-propylamine | 340 | - | 820 | 93 | 429 | 16 | 17.2 | Yes |
| N-nitrosodiphenylamine | 340 | - | 820 | 94 | 612,250 | 0 | 0 | No |
| n-Propylbenzene | 1.07 | - | 1.21 | 13 | | 0 | 0 | No |
| PCB-1016 | 34 | - | 730 | 90 | 1,349 | 0 | 0 | No |
| PCB-1221 | 34 | - | 730 | 90 | 1,349 | 0 | 0 | No |
| PCB-1232 | 34 | - | 730 | 90 | 1,349 | 0 | 0 | No |
| PCB-1242 | 34 | - | 730 | 90 | 1,349 | 0 | 0 | No |
| PCB-1248 | 34 | - | 730 | 89 | 1,349 | 0 | 0 | Yes |
| Pentachlorophenol | 1,600 | - | 4,100 | 89 | 17,633 | 0 | 0 | No |
| Phenol | 340 | - | 820 | 89 | 2.40E+07 | 0 | 0 | No |
| Pyridine | 730 | - | 820 | 8 | | 0 | 0 | No |
| sec-Butylbenzene | 1.01 | - | 1.14 | 13 | | 0 | 0 | No |
| Styrene | 0.970 | - | 12 | 21 | 1.38E+07 | 0 | 0 | No |
| tert-Butylbenzene | 1.06 | - | 1.20 | 13 | | 0 | 0 | No |
| Tetrachloroethene | 1.18 | - | 12 | 20 | 6,705 | 0 | 0 | Yes |
| Toluene | 1.22 | - | 12 | 20 | 3.09E+06 | 0 | 0 | Yes |
| Toxaphene | 160 | - | 980 | 49 | 2,720 | 0 | 0 | No |
| trans-1,2-Dichloroethene | 1.29 | - | 1.46 | 13 | 287,340 | 0 | 0 | No |
| trans-1,3-Dichloropropene | 0.866 | - | 12 | 21 | 20,820 | 0 | 0 | No |
| Trichloroethene | 0.614 | - | 12 | 21 | 1,770 | 0 | 0 | No |
| Trichlorofluoromethane | 1.21 | - | 1.37 | 13 | 1.51E+06 | 0 | 0 | No |
| Vinyl acetate | 11 | - | 24 | 8 | 2.65E+06 | 0 | 0 | No |
| Vinyl Chloride | 2.72 | - | 24 | 21 | 2,169 | 0 | 0 | No |
| Xylene | 2.42 | - | 12 | 21 | 1.06E+06 | 0 | 0 | No |

**Table A1.2**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | PRG | Number of Nondetected Results > | Percent Nondetected Results > | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| **Inorganic (mg/kg)** | | | | | | | | |
| Cyanide | 0.0442 | - | 0.640 | 67 | 25,550 | 0 | 0 | No |
| Selenium | 0.200 | - | 49.1 | 295 | 6,388 | 0 | 0 | Yes |
| **Organic (ug/kg)** | | | | | | | | |
| 1,1,1,2-Tetrachloroethane | 0.497 | - | 5,500 | 279 | 1.05E+06 | 0 | 0 | No |
| 1,1,1-Trichloroethane | 0.778 | - | 5,500 | 485 | 1.06E+08 | 0 | 0 | Yes |
| 1,1,2,2-Tetrachloroethane | 0.522 | - | 5,500 | 484 | 120,551 | 0 | 0 | Yes |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.888 | - | 5,500 | 283 | 2.74E+10 | 0 | 0 | Yes |
| 1,1,2-Trichloroethane | 0.497 | - | 5,500 | 496 | 322,253 | 0 | 0 | No |
| 1,1-Dichloroethane | 0.507 | - | 5,500 | 491 | 3.12E+07 | 0 | 0 | No |
| 1,1-Dichloroethene | 0.632 | - | 5,500 | 489 | 199,706 | 0 | 0 | Yes |
| 1,1-Dichloropropene | 1.01 | - | 5,500 | 279 | | 0 | 0 | No |
| 1,2,3-Trichlorobenzene | 0.637 | - | 5,500 | 274 | | 0 | 0 | Yes |
| 1,2,3-Trichloropropane | 0.938 | - | 5,500 | 279 | 23,910 | 0 | 0 | No |
| 1,2,4,5-Tetrachlorobenzene | 340 | - | 3,600 | 53 | 276,495 | 0 | 0 | No |
| 1,2,4-Trichlorobenzene | 0.753 | - | 3,600 | 406 | 1.74E+06 | 0 | 0 | Yes |
| 1,2,4-Trimethylbenzene | 0.586 | - | 5,500 | 266 | 1.53E+06 | 0 | 0 | Yes |
| 1,2-Dibromo-3-chloropropane | 1.36 | - | 5,500 | 279 | 34,137 | 0 | 0 | No |
| 1,2-Dibromoethane | 0.497 | - | 5,500 | 279 | 403 | 13 | 4.66 | No |
| 1,2-Dichlorobenzene | 0.497 | - | 3,600 | 413 | 3.32E+07 | 0 | 0 | Yes |
| 1,2-Dichloroethane | 0.517 | - | 5,500 | 489 | 152,603 | 0 | 0 | No |
| 1,2-Dichloroethene | 5 | - | 1,500 | 152 | 1.15E+07 | 0 | 0 | Yes |
| 1,2-Dichloropropane | 0.497 | - | 5,500 | 491 | 441,907 | 0 | 0 | No |
| 1,2-Diphenylhydrazine | 340 | - | 3,600 | 53 | 43,021 | 0 | 0 | No |
| 1,3,5-Trimethylbenzene | 0.530 | - | 5,500 | 274 | 1.31E+06 | 0 | 0 | Yes |
| 1,3-Dichlorobenzene | 0.500 | - | 3,600 | 409 | 3.83E+07 | 0 | 0 | Yes |
| 1,3-Dichloropropane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| 1,4-Dichlorobenzene | 0.924 | - | 3,600 | 407 | 1.05E+06 | 0 | 0 | Yes |
| 1,4-Dioxane | 103 | - | 114 | 5 | 4.35E+06 | 0 | 0 | No |
| 2,2-Dichloropropane | 0.720 | - | 5,500 | 279 | | 0 | 0 | No |
| 2,4,5-T | 21 | - | 22 | 5 | 9.22E+06 | 0 | 0 | No |
| 2,4,5-TP (Silvex) | 21 | - | 22 | 5 | 1.95E+06 | 0 | 0 | No |
| 2,4,5-Trichlorophenol | 330 | - | 77,000 | 249 | 9.22E+07 | 0 | 0 | No |
| 2,4,6-Trichlorophenol | 330 | - | 77,000 | 249 | 3.13E+06 | 0 | 0 | No |
| 2,4-D | 83 | - | 87 | 5 | 9.22E+06 | 0 | 0 | No |
| 2,4-DB | 83 | - | 87 | 5 | 7.37E+06 | 0 | 0 | No |
| 2,4-Dichlorophenol | 330 | - | 77,000 | 249 | 2.76E+06 | 0 | 0 | No |
| 2,4-Dimethylphenol | 330 | - | 77,000 | 249 | 1.84E+07 | 0 | 0 | No |
| 2,4-Dinitrophenol | 1,600 | - | 380,000 | 249 | 1.84E+06 | 0 | 0 | No |
| 2,4-Dinitrotoluene | 330 | - | 77,000 | 249 | 1.84E+06 | 0 | 0 | No |
| 2,6-Dinitrotoluene | 330 | - | 77,000 | 249 | 921,651 | 0 | 0 | No |
| 2-Chloroethyl vinyl ether | 10 | - | 1,600 | 59 | | 0 | 0 | No |
| 2-Chloronaphthalene | 330 | - | 77,000 | 249 | 7.37E+07 | 0 | 0 | No |
| 2-Chlorophenol | 330 | - | 77,000 | 248 | 6.39E+06 | 0 | 0 | Yes |
| 2-Chlorotoluene | 0.528 | - | 5,500 | 279 | 2.56E+07 | 0 | 0 | No |
| 2-Hexanone | 5 | - | 22,000 | 470 | | 0 | 0 | Yes |
| 2-Methyl-1-propanol | 103 | - | 114 | 5 | 3.83E+08 | 0 | 0 | No |
| 2-Methylnaphthalene | 330 | - | 3,900 | 244 | 3.69E+06 | 0 | 0 | Yes |
| 2-Methylphenol | 330 | - | 77,000 | 254 | 4.61E+07 | 0 | 0 | No |
| 2-Nitroaniline | 360 | - | 380,000 | 249 | 2.21E+06 | 0 | 0 | No |
| 2-Nitrophenol | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 3 & 4-methyl phenol | 1,010 | - | 1,080 | 5 | | 0 | 0 | No |
| 3,3'-Dichlorobenzidine | 680 | - | 150,000 | 240 | 76,667 | 1 | 0.417 | No |
| 3-Nitroaniline | 380 | - | 380,000 | 243 | | 0 | 0 | No |

**Table A1.2**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | PRG | Number of Nondetected Results > | Percent Nondetected Results > | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| 4,4'-DDD | 3.60 | - | 1,190 | 81 | 178,570 | 0 | 0 | No |
| 4,4'-DDE | 3.60 | - | 430 | 81 | 126,049 | 0 | 0 | No |
| 4,4'-DDT | 3.60 | - | 1,270 | 81 | 125,658 | 0 | 0 | No |
| 4,6-Dinitro-2-methylphenol | 1,600 | - | 380,000 | 249 | 92,165 | 1 | 0.402 | No |
| 4-Bromophenyl-phenylether | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 4-Chloro-3-methylphenol | 330 | - | 150,000 | 248 | | 0 | 0 | Yes |
| 4-Chloroaniline | 330 | - | 150,000 | 249 | 3.69E+06 | 0 | 0 | No |
| 4-Chlorophenyl-phenyl ether | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 4-Chlorotoluene | 0.837 | - | 5,500 | 279 | | 0 | 0 | No |
| 4-Isopropyltoluene | 0.609 | - | 5,500 | 276 | | 0 | 0 | Yes |
| 4-Methyl-2-pentanone | 5 | - | 22,000 | 475 | 9.57E+08 | 0 | 0 | Yes |
| 4-Methylphenol | 330 | - | 77,000 | 249 | 4.61E+06 | 0 | 0 | No |
| 4-Nitroaniline | 1,600 | - | 380,000 | 245 | 2.39E+06 | 0 | 0 | No |
| 4-Nitrophenol | 390 | - | 380,000 | 249 | 7.37E+06 | 0 | 0 | No |
| Acenaphthene | 330 | - | 3,900 | 243 | 5.10E+07 | 0 | 0 | Yes |
| Acenaphthylene | 330 | - | 38,000 | 248 | | 0 | 0 | Yes |
| Acetonitrile | 103 | - | 114 | 5 | | 0 | 0 | No |
| Aldrin | 1.80 | - | 430 | 81 | 2,024 | 0 | 0 | No |
| alpha-BHC | 1.80 | - | 318 | 81 | 6,555 | 0 | 0 | No |
| alpha-Chlordane | 1.80 | - | 1,700 | 76 | 117,997 | 0 | 0 | No |
| Anthracene | 330 | - | 3,900 | 241 | 2.55E+08 | 0 | 0 | Yes |
| Benzene | 0.497 | - | 5,500 | 495 | 270,977 | 0 | 0 | Yes |
| Benzo(b)fluoranthene | 330 | - | 77,000 | 239 | 43,616 | 1 | 0.418 | Yes |
| Benzo(k)fluoranthene | 330 | - | 77,000 | 243 | 436,159 | 0 | 0 | Yes |
| Benzyl Alcohol | 330 | - | 150,000 | 249 | 2.76E+08 | 0 | 0 | No |
| beta-BHC | 1.80 | - | 637 | 81 | 22,942 | 0 | 0 | No |
| beta-Chlordane | 1.80 | - | 1,700 | 76 | 117,997 | 0 | 0 | No |
| bis(2-Chloroethoxy) methane | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| bis(2-Chloroethyl) ether | 330 | - | 77,000 | 249 | 43,315 | 1 | 0.402 | No |
| bis(2-Chloroisopropyl) ether | 330 | - | 77,000 | 246 | 681,967 | 0 | 0 | No |
| Bromobenzene | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| Bromochloromethane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| Bromodichloromethane | 0.497 | - | 5,500 | 491 | 771,304 | 0 | 0 | No |
| Bromoform | 0.594 | - | 5,500 | 485 | 4.83E+06 | 0 | 0 | No |
| Bromomethane | 0.963 | - | 5,500 | 486 | 241,033 | 0 | 0 | No |
| Carbon Disulfide | 0.888 | - | 15,000 | 490 | 1.88E+07 | 0 | 0 | Yes |
| Carbon Tetrachloride | 0.849 | - | 5,500 | 479 | 97,124 | 0 | 0 | Yes |
| Chlordane | 290 | - | 1,510 | 5 | 117,997 | 0 | 0 | No |
| Chlorobenzene | 0.497 | - | 5,500 | 496 | 7.67E+06 | 0 | 0 | No |
| Chloroethane | 1.08 | - | 5,500 | 488 | 1.65E+07 | 0 | 0 | No |
| Chloromethane | 1.01 | - | 5,500 | 486 | 1.32E+06 | 0 | 0 | No |
| cis-1,3-Dichloropropene | 0.497 | - | 5,500 | 491 | 223,462 | 0 | 0 | No |
| Dalapon | 42 | - | 44 | 5 | 2.76E+07 | 0 | 0 | No |
| delta-BHC | 1.80 | - | 952 | 81 | 6,555 | 0 | 0 | No |
| Dibenz(a,h)anthracene | 330 | - | 77,000 | 247 | 4,362 | 1 | 0.405 | Yes |
| Dibenzofuran | 330 | - | 3,900 | 248 | 2.56E+06 | 0 | 0 | Yes |
| Dibromochloromethane | 0.497 | - | 5,500 | 491 | 569,296 | 0 | 0 | No |
| Dibromomethane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| Dichlorodifluoromethane | 1.72 | - | 5,500 | 279 | 2.64E+06 | 0 | 0 | No |
| Dichloroprop | 83 | - | 87 | 5 | | 0 | 0 | No |
| Dieldrin | 3.60 | - | 340 | 81 | 2,151 | 0 | 0 | No |
| Diethylphthalate | 340 | - | 77,000 | 248 | 7.37E+08 | 0 | 0 | Yes |
| Dimethylphthalate | 330 | - | 77,000 | 249 | 9.22E+09 | 0 | 0 | No |
| Di-n-octylphthalate | 330 | - | 77,000 | 249 | 3.69E+07 | 0 | 0 | No |

**Table A1.2**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | PRG | Number of Nondetected Results > | Percent Nondetected Results > | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| Dinoseb | 12 | - | 13 | 5 | 921,651 | 0 | 0 | No |
| Endosulfan I | 1.80 | - | 222 | 81 | 5.53E+06 | 0 | 0 | No |
| Endosulfan II | 3.60 | - | 430 | 80 | 5.53E+06 | 0 | 0 | No |
| Endosulfan sulfate | 3.60 | - | 7,140 | 81 | 5.53E+06 | 0 | 0 | No |
| Endrin | 3.60 | - | 637 | 81 | 276,495 | 0 | 0 | No |
| Endrin aldehyde | 3.60 | - | 2,460 | 9 | 276,495 | 0 | 0 | No |
| Endrin ketone | 3.60 | - | 340 | 76 | 383,250 | 0 | 0 | No |
| Ether | 52.3 | - | 57 | 3 | 2.56E+08 | 0 | 0 | No |
| ethyl acetate | 51.3 | - | 57 | 5 | 1.15E+09 | 0 | 0 | No |
| Ethylbenzene | 0.497 | - | 5,500 | 492 | 6.19E+07 | 0 | 0 | Yes |
| Fluorene | 330 | - | 3,900 | 245 | 3.69E+07 | 0 | 0 | Yes |
| gamma-BHC (Lindane) | 1.80 | - | 430 | 81 | 31,864 | 0 | 0 | No |
| Heptachlor | 1.80 | - | 318 | 81 | 7,647 | 0 | 0 | No |
| Heptachlor epoxide | 1.80 | - | 857 | 81 | 3,782 | 0 | 0 | No |
| Hexachlorobenzene | 330 | - | 77,000 | 249 | 21,508 | 1 | 0.402 | No |
| Hexachlorobutadiene | 0.639 | - | 3,600 | 407 | 255,500 | 0 | 0 | Yes |
| Hexachlorocyclopentadiene | 340 | - | 77,000 | 249 | 4.38E+06 | 0 | 0 | No |
| Hexachloroethane | 330 | - | 77,000 | 249 | 1.28E+06 | 0 | 0 | No |
| Indeno(1,2,3-cd)pyrene | 330 | - | 77,000 | 240 | 43,616 | 1 | 0.417 | Yes |
| Isophorone | 330 | - | 77,000 | 249 | 3.63E+07 | 0 | 0 | No |
| Isopropylbenzene | 0.497 | - | 5,500 | 279 | 375,823 | 0 | 0 | No |
| MCPA | 8,300 | - | 8,700 | 5 | 460,825 | 0 | 0 | No |
| MCPP | 8,300 | - | 8,700 | 5 | 921,651 | 0 | 0 | No |
| Methoxychlor | 18 | - | 19,100 | 81 | 4.61E+06 | 0 | 0 | No |
| n-Butanol | 103 | - | 114 | 5 | | 0 | 0 | No |
| n-Butylbenzene | 0.705 | - | 5,500 | 278 | | 0 | 0 | Yes |
| Nitrobenzene | 330 | - | 77,000 | 254 | 497,333 | 0 | 0 | No |
| N-Nitrosodiethylamine | 680 | - | 7,300 | 53 | 229 | 53 | 100 | No |
| N-Nitrosodimethylamine | 680 | - | 7,300 | 53 | 675 | 53 | 100 | No |
| N-Nitrosodi-n-butylamine | 340 | - | 3,600 | 53 | 5,977 | 0 | 0 | No |
| N-Nitroso-di-n-propylamine | 330 | - | 77,000 | 249 | 4,929 | 1 | 0.402 | No |
| N-nitrosodiphenylamine | 330 | - | 3,900 | 246 | 7.04E+06 | 0 | 0 | Yes |
| n-Propylbenzene | 0.664 | - | 5,500 | 279 | | 0 | 0 | No |
| o-Xylene | 6 | - | 6 | 1 | 1.22E+07 | 0 | 0 | No |
| PCB-1016 | 33 | - | 21,700 | 189 | 15,514 | 1 | 0.529 | No |
| PCB-1221 | 33 | - | 21,700 | 189 | 15,514 | 1 | 0.529 | No |
| PCB-1232 | 33 | - | 21,700 | 189 | 15,514 | 1 | 0.529 | No |
| PCB-1242 | 33 | - | 21,700 | 189 | 15,514 | 1 | 0.529 | No |
| PCB-1248 | 33 | - | 21,700 | 188 | 15,514 | 1 | 0.532 | Yes |
| PCB-1260 | 21 | - | 3,400 | 182 | 15,514 | 0 | 0 | Yes |
| Pentachlorobenzene | 340 | - | 3,600 | 53 | 737,321 | 0 | 0 | No |
| Pentachlorophenol | 1,600 | - | 380,000 | 248 | 202,777 | 1 | 0.403 | Yes |
| Pyridine | 680 | - | 77,000 | 35 | | 0 | 0 | No |
| sec-Butylbenzene | 0.613 | - | 5,500 | 279 | | 0 | 0 | No |
| Styrene | 0.545 | - | 5,500 | 489 | 1.59E+08 | 0 | 0 | Yes |
| tert-Butylbenzene | 0.709 | - | 5,500 | 279 | | 0 | 0 | No |
| Toxaphene | 86 | - | 27,000 | 81 | 31,284 | 0 | 0 | No |
| trans-1,2-Dichloroethene | 0.732 | - | 2,800 | 335 | 3.30E+06 | 0 | 0 | No |
| trans-1,3-Dichloropropene | 0.497 | - | 5,500 | 487 | 239,434 | 0 | 0 | No |
| Trichlorofluoromethane | 1.17 | - | 5,500 | 284 | 1.74E+07 | 0 | 0 | No |
| Vinyl acetate | 6 | - | 7,800 | 195 | 3.04E+07 | 0 | 0 | No |
| Vinyl Chloride | 0.980 | - | 5,500 | 491 | 24,948 | 0 | 0 | No |

**Table A1.3**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | Lowest ESL | Number of Nondetected Results > ESL | Percent Nondetected Results > ESL | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| **Inorganic (mg/kg)** | | | | | | | | |
| Chromium VI | 0.960 | - | 1.20 | 4 | 1.34 | 0 | 0 | No |
| **Organic (ug/kg)** | | | | | | | | |
| 1,1,1,2-Tetrachloroethane | 1.15 | - | 1.30 | 13 | | 0 | 0 | No |
| 1,1,1-Trichloroethane | 1.02 | - | 1.16 | 13 | 551,453 | 0 | 0 | No |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.911 | - | 1.03 | 13 | | 0 | 0 | No |
| 1,1,2-Trichloroethane | 0.865 | - | 0.979 | 13 | | 0 | 0 | No |
| 1,1-Dichloroethane | 0.918 | - | 1.04 | 13 | 3,121 | 0 | 0 | No |
| 1,1-Dichloroethene | 1.38 | - | 1.56 | 13 | 16,909 | 0 | 0 | No |
| 1,1-Dichloropropene | 1.17 | - | 1.33 | 13 | | 0 | 0 | No |
| 1,2,3-Trichlorobenzene | 0.653 | - | 0.739 | 13 | | 0 | 0 | No |
| 1,2,4-Trichlorobenzene | 0.904 | - | 820 | 98 | 777 | 4 | 4.08 | No |
| 1,2-Dibromo-3-chloropropane | 1.68 | - | 1.90 | 13 | | 0 | 0 | No |
| 1,2-Dibromoethane | 0.766 | - | 0.867 | 13 | | 0 | 0 | No |
| 1,2-Dichlorobenzene | 0.682 | - | 430 | 90 | | 0 | 0 | No |
| 1,2-Dichloroethane | 0.930 | - | 1.05 | 13 | 2,764 | 0 | 0 | No |
| 1,2-Dichloropropane | 0.799 | - | 0.904 | 13 | 49,910 | 0 | 0 | No |
| 1,3,5-Trimethylbenzene | 0.908 | - | 1.03 | 13 | 7,598 | 0 | 0 | No |
| 1,3-Dichlorobenzene | 0.951 | - | 820 | 98 | | 0 | 0 | No |
| 1,3-Dichloropropane | 0.540 | - | 0.612 | 13 | | 0 | 0 | No |
| 1,4-Dichlorobenzene | 1.03 | - | 430 | 90 | 20,000 | 0 | 0 | No |
| 2,2-Dichloropropane | 0.945 | - | 1.07 | 13 | | 0 | 0 | No |
| 2,4,5-Trichlorophenol | 340 | - | 2,100 | 80 | 4,000 | 0 | 0 | No |
| 2,4,6-Trichlorophenol | 340 | - | 820 | 80 | 161 | 80 | 100 | No |
| 2,4-Dichlorophenol | 340 | - | 820 | 80 | 2,744 | 0 | 0 | No |
| 2,4-Dimethylphenol | 340 | - | 820 | 80 | | 0 | 0 | No |
| 2,4-Dinitrophenol | 1,600 | - | 4,100 | 80 | 20,000 | 0 | 0 | No |
| 2,4-Dinitrotoluene | 340 | - | 820 | 85 | 32.1 | 85 | 100 | No |
| 2,6-Dinitrotoluene | 340 | - | 820 | 85 | 6,186 | 0 | 0 | No |
| 2-Butanone | 9.29 | - | 10.5 | 13 | 1.07E+06 | 0 | 0 | No |
| 2-Chloronaphthalene | 340 | - | 820 | 85 | | 0 | 0 | No |
| 2-Chlorophenol | 340 | - | 820 | 80 | 281 | 80 | 100 | No |
| 2-Chlorotoluene | 1.47 | - | 1.66 | 13 | | 0 | 0 | No |
| 2-Hexanone | 7.44 | - | 8.42 | 13 | | 0 | 0 | No |
| 2-Methylnaphthalene | 340 | - | 820 | 85 | 2,769 | 0 | 0 | No |
| 2-Methylphenol | 340 | - | 820 | 80 | 123,842 | 0 | 0 | No |
| 2-Nitroaniline | 1,600 | - | 4,100 | 85 | 5,659 | 0 | 0 | No |
| 2-Nitrophenol | 340 | - | 820 | 80 | | 0 | 0 | No |
| 3,3'-Dichlorobenzidine | 670 | - | 1,600 | 85 | | 0 | 0 | No |
| 3-Nitroaniline | 1,600 | - | 4,100 | 82 | | 0 | 0 | No |
| 4,4'-DDD | 9.10 | - | 21 | 40 | 13,726 | 0 | 0 | No |
| 4,4'-DDT | 9.10 | - | 22 | 40 | 1.20 | 40 | 100 | No |
| 4,6-Dinitro-2-methylphenol | 1,600 | - | 4,100 | 79 | 560 | 79 | 100 | Yes |
| 4-Bromophenyl-phenylether | 340 | - | 820 | 85 | | 0 | 0 | No |
| 4-Chloro-3-methylphenol | 340 | - | 1,600 | 80 | | 0 | 0 | No |
| 4-Chloroaniline | 340 | - | 1,600 | 85 | 716 | 8 | 9.41 | No |
| 4-Chlorophenyl-phenyl ether | 340 | - | 820 | 85 | | 0 | 0 | No |
| 4-Chlorotoluene | 0.861 | - | 0.975 | 13 | | 0 | 0 | No |
| 4-Isopropyltoluene | 1.01 | - | 1.15 | 13 | | 0 | 0 | No |
| 4-Methyl-2-pentanone | 6.29 | - | 7.12 | 13 | 14,630 | 0 | 0 | No |
| 4-Methylphenol | 340 | - | 820 | 80 | | 0 | 0 | No |
| 4-Nitroaniline | 1,600 | - | 4,100 | 85 | 41,050 | 0 | 0 | No |
| 4-Nitrophenol | 1,600 | - | 4,100 | 80 | 7,000 | 0 | 0 | No |

**Table A1.3**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | Lowest ESL | Number of Nondetected Results > ESL | Percent Nondetected Results > ESL | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| Acenaphthylene | 340 | - | 430 | 85 | | 0 | 0 | No |
| Acetone | 11.4 | - | 12.9 | 13 | 6,182 | 0 | 0 | No |
| Aldrin | 8.10 | - | 14 | 40 | 47.0 | 0 | 0 | No |
| alpha-BHC | 8.10 | - | 10 | 40 | 18,662 | 0 | 0 | No |
| alpha-Chlordane | 80 | - | 100 | 36 | 289 | 0 | 0 | No |
| Benzyl Alcohol | 340 | - | 1,600 | 80 | 4,403 | 0 | 0 | No |
| beta-BHC | 8.10 | - | 10 | 40 | 207 | 0 | 0 | No |
| beta-Chlordane | 81 | - | 100 | 36 | 289 | 0 | 0 | No |
| bis(2-Chloroethoxy) methane | 340 | - | 820 | 85 | | 0 | 0 | No |
| bis(2-Chloroethyl) ether | 340 | - | 820 | 85 | | 0 | 0 | No |
| bis(2-Chloroisopropyl) ether | 340 | - | 820 | 85 | | 0 | 0 | No |
| Bromobenzene | 1.02 | - | 1.15 | 13 | | 0 | 0 | No |
| Bromochloromethane | 1.08 | - | 1.23 | 13 | | 0 | 0 | No |
| Bromodichloromethane | 0.637 | - | 0.721 | 13 | 5,750 | 0 | 0 | No |
| Bromoform | 1.03 | - | 1.17 | 13 | 2,855 | 0 | 0 | No |
| Bromomethane | 1.48 | - | 1.68 | 13 | | 0 | 0 | No |
| Butylbenzylphthalate | 340 | - | 820 | 85 | 24,155 | 0 | 0 | No |
| Carbon Disulfide | 2.57 | - | 2.91 | 13 | 5,676 | 0 | 0 | No |
| Carbon Tetrachloride | 1.09 | - | 1.24 | 13 | 8,906 | 0 | 0 | No |
| Chlordane | 91 | - | 98 | 4 | 289 | 0 | 0 | No |
| Chloroethane | 3.62 | - | 4.09 | 13 | | 0 | 0 | No |
| Chloroform | 0.830 | - | 0.940 | 13 | 8,655 | 0 | 0 | No |
| Chloromethane | 1.30 | - | 1.47 | 13 | | 0 | 0 | No |
| cis-1,2-Dichloroethene | 0.984 | - | 1.11 | 13 | 1,814 | 0 | 0 | No |
| cis-1,3-Dichloropropene | 0.810 | - | 0.917 | 13 | 2,800 | 0 | 0 | No |
| delta-BHC | 8.10 | - | 10 | 40 | 25.9 | 0 | 0 | No |
| Dibenz(a,h)anthracene | 340 | - | 820 | 81 | | 0 | 0 | Yes |
| Dibenzofuran | 340 | - | 820 | 83 | 21,200 | 0 | 0 | Yes |
| Dibromochloromethane | 0.676 | - | 0.765 | 13 | 5,730 | 0 | 0 | No |
| Dibromomethane | 0.706 | - | 0.799 | 13 | | 0 | 0 | No |
| Dichlorodifluoromethane | 1.76 | - | 2.00 | 13 | 855 | 0 | 0 | No |
| Diethylphthalate | 340 | - | 840 | 85 | 100,000 | 0 | 0 | No |
| Dimethylphthalate | 340 | - | 820 | 85 | 200,000 | 0 | 0 | No |
| Di-n-butylphthalate | 340 | - | 820 | 84 | 15.9 | 84 | 100 | Yes |
| Di-n-octylphthalate | 340 | - | 820 | 85 | 731,367 | 0 | 0 | No |
| Endosulfan I | 8.10 | - | 10 | 40 | 80.1 | 0 | 0 | No |
| Endosulfan II | 9.10 | - | 29 | 40 | 80.1 | 0 | 0 | No |
| Endosulfan sulfate | 9.10 | - | 26 | 40 | 80.1 | 0 | 0 | No |
| Endrin aldehyde | 9.10 | - | 9.80 | 4 | 1.40 | 4 | 100 | No |
| Endrin ketone | 16 | - | 21 | 36 | 1.40 | 36 | 100 | No |
| Fluorene | 340 | - | 820 | 81 | 30,000 | 0 | 0 | Yes |
| gamma-BHC (Lindane) | 8.10 | - | 10 | 40 | 25.9 | 0 | 0 | No |
| Heptachlor | 8.10 | - | 10 | 40 | 63.3 | 0 | 0 | No |
| Heptachlor epoxide | 8.10 | - | 38 | 40 | 64.0 | 0 | 0 | No |
| Hexachlorobenzene | 340 | - | 820 | 85 | 7.73 | 85 | 100 | No |
| Hexachlorobutadiene | 1.15 | - | 820 | 98 | 431 | 8 | 8.16 | No |
| Hexachlorocyclopentadiene | 340 | - | 840 | 85 | 5,518 | 0 | 0 | No |
| Hexachloroethane | 340 | - | 820 | 85 | 366 | 41 | 48.2 | No |
| Isophorone | 340 | - | 820 | 85 | | 0 | 0 | No |
| Isopropylbenzene | 1.20 | - | 1.36 | 13 | | 0 | 0 | No |
| Methylene Chloride | 1.04 | - | 1.18 | 13 | 3,399 | 0 | 0 | No |
| Naphthalene | 0.765 | - | 820 | 97 | 27,048 | 0 | 0 | Yes |
| n-Butylbenzene | 0.958 | - | 1.08 | 13 | | 0 | 0 | No |

**Table A1.3**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | Lowest ESL | Number of Nondetected Results > ESL | Percent Nondetected Results > ESL | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| Nitrobenzene | 340 | - | 820 | 80 | 40,000 | 0 | 0 | No |
| N-Nitroso-di-n-propylamine | 340 | - | 820 | 84 | | 0 | 0 | Yes |
| N-nitrosodiphenylamine | 340 | - | 820 | 85 | 20,000 | 0 | 0 | No |
| n-Propylbenzene | 1.07 | - | 1.21 | 13 | | 0 | 0 | No |
| PCB-1016 | 34 | - | 730 | 81 | 172 | 3 | 3.70 | No |
| PCB-1221 | 34 | - | 730 | 81 | 172 | 3 | 3.70 | No |
| PCB-1232 | 34 | - | 730 | 81 | 172 | 3 | 3.70 | No |
| PCB-1242 | 34 | - | 730 | 81 | 172 | 3 | 3.70 | No |
| PCB-1248 | 34 | - | 730 | 80 | 172 | 3 | 3.75 | Yes |
| Pentachlorophenol | 1,600 | - | 4,100 | 80 | 122 | 80 | 100 | No |
| Phenol | 340 | - | 820 | 80 | 23,090 | 0 | 0 | No |
| Pyridine | 730 | - | 820 | 8 | | 0 | 0 | No |
| sec-Butylbenzene | 1.01 | - | 1.14 | 13 | | 0 | 0 | No |
| Styrene | 0.970 | - | 1.10 | 13 | 16,408 | 0 | 0 | No |
| tert-Butylbenzene | 1.06 | - | 1.20 | 13 | | 0 | 0 | No |
| Toxaphene | 160 | - | 980 | 40 | 3,756 | 0 | 0 | No |
| trans-1,2-Dichloroethene | 1.29 | - | 1.46 | 13 | 25,617 | 0 | 0 | No |
| trans-1,3-Dichloropropene | 0.866 | - | 0.981 | 13 | 2,800 | 0 | 0 | No |
| Trichloroethene | 0.614 | - | 0.695 | 13 | 389 | 0 | 0 | No |
| Trichlorofluoromethane | 1.21 | - | 1.37 | 13 | | 0 | 0 | No |
| Vinyl Chloride | 2.72 | - | 3.08 | 13 | 97.7 | 0 | 0 | No |
| Xylene | 2.42 | - | 2.74 | 13 | 1,140 | 0 | 0 | No |

**Table A1.4**
**Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level**

| Analyte | Total Number of Results | Detection Frequency (%) | Number of Detects | Minimum Detected Conc. | Maximum Detected Conc. | Minimum Nondetected Result | Maximum Nondetected Result | Minimum ESL |
|---|---|---|---|---|---|---|---|---|
| **Inorganics (mg/kg)** | | | | | | | | |
| Aluminum | 2,622 | 99.9 | 2,620 | 1,450 | 61,000 | 10.9 | 70 | 50 |
| Ammonia | 32 | 78.1 | 25 | 0.335 | 4.81 | 0.338 | 6.12 | 586 |
| Antimony | 2,482 | 20.0 | 497 | 0.270 | 348 | 0.0360 | 19.3 | 0.905 |
| Arsenic | 2,613 | 99.0 | 2,586 | 0.290 | 56.2 | 0.400 | 6.20 | 2.57 |
| Barium | 2,624 | 99.9 | 2,622 | 0.640 | 1,500 | 2.20 | 95 | 159 |
| Beryllium | 2,623 | 81.7 | 2,142 | 0.0710 | 26.8 | 0.0620 | 1.90 | 6.82 |
| Boron | 1,303 | 85.7 | 1,117 | 0.350 | 28 | 0.340 | 7 | 0.500 |
| Cadmium | 2,603 | 36.1 | 940 | 0.0600 | 270 | 0.0300 | 2.80 | 0.705 |
| Chromium | 2,624 | 99.2 | 2,604 | 1.20 | 210 | 2.20 | 19.8 | 0.400 |
| Chromium VI | 17 | 5.88 | 1.000 | 0.850 | 0.850 | 0.530 | 1.20 | 1.34 |
| Cobalt | 2,622 | 98.1 | 2,573 | 1.10 | 137 | 2.10 | 10.4 | 13 |
| Copper | 2,621 | 98.2 | 2,575 | 1.70 | 1,860 | 2.20 | 22.8 | 8.25 |
| Cyanide | 245 | 2.45 | 6.00 | 0.170 | 0.290 | 0.180 | 4.70 | 607 |
| Fluoride | 9 | 100 | 9 | 1.87 | 3.61 | NA | NA | 1.33 |
| Lead | 2,618 | 100 | 2,618 | 0.870 | 814 | NA | NA | 12.1 |
| Lithium | 2,433 | 94.5 | 2,300 | 0.990 | 50 | 1.60 | 20.6 | 2 |
| Manganese | 2,617 | 99.9 | 2,615 | 15 | 2,220 | 2.20 | 130 | 486 |
| Mercury | 2,541 | 48.8 | 1,239 | 0.00140 | 48 | 0.00120 | 0.190 | 1.00E-04 |
| Molybdenum | 2,421 | 47.0 | 1,138 | 0.140 | 19.1 | 0.0990 | 7.50 | 1.84 |
| Nickel | 2,620 | 97.5 | 2,554 | 1.90 | 280 | 1.60 | 19.1 | 0.431 |
| Nitrate / Nitrite | 450 | 83.3 | 375 | 0.216 | 765 | 0.200 | 5.60 | 4,478 |
| Selenium | 2,590 | 13.3 | 345 | 0.220 | 2.20 | 0.0540 | 4.50 | 0.754 |
| Silver | 2,589 | 28.4 | 735 | 0.0580 | 364 | 0.0490 | 7 | 2 |
| Strontium | 2,423 | 100.0 | 2,422 | 2.40 | 413 | 1.10 | 1.10 | 940 |
| Thallium | 2,597 | 14.1 | 366 | 0.100 | 5.80 | 0.0160 | 2.50 | 1 |
| Tin | 2,423 | 10.0 | 243 | 0.289 | 161 | 0.0780 | 58.5 | 2.90 |
| Uranium | 1,296 | 8.80 | 114 | 0.430 | 370 | 0.130 | 16.8 | 5 |
| Vanadium | 2,622 | 100.0 | 2,621 | 4.40 | 5,300 | 2.20 | 2.20 | 2 |

**Table A1.4**
**Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level**

| Analyte | Total Number of Results | Detection Frequency (%) | Number of Detects | Minimum Detected Conc. | Maximum Detected Conc. | Minimum Nondetected Result | Maximum Nondetected Result | Minimum ESL |
|---|---|---|---|---|---|---|---|---|
| Zinc | 2,622 | 99.8 | 2,617 | 4.20 | 11,900 | 2.20 | 99.8 | 0.646 |
| **Organics (ug/kg)** | | | | | | | | |
| 1,1,1-Trichloroethane | 633 | 1.58 | 10.00 | 1.10 | 47.7 | 0.587 | 680 | 551,453 |
| 1,1,2,2-Tetrachloroethane | 632 | 0.158 | 1.000 | 1.39 | 1.39 | 0.527 | 680 | 60,701 |
| 1,1-Dichloroethane | 633 | 0 | 0 | NA | NA | 0.512 | 680 | 3,121 |
| 1,1-Dichloroethene | 633 | 0.158 | 1.000 | 7.90 | 7.90 | 0.610 | 680 | 16,909 |
| 1,2,3-Trichloropropane | 517 | 0.193 | 1.000 | 1.47 | 1.47 | 0.525 | 129 | 13,883 |
| 1,2,4-Trichlorobenzene | 1,549 | 0.323 | 5.00 | 0.870 | 150 | 0.621 | 7,000 | 777 |
| 1,2-Dichloroethane | 629 | 0 | 0 | NA | NA | 0.522 | 680 | 2,764 |
| 1,2-Dichloroethene | 101 | 0.990 | 1.000 | 16 | 16 | 5 | 680 | 25,617 |
| 1,2-Dichloropropane | 633 | 0.316 | 2.00 | 18 | 140 | 0.413 | 680 | 49,910 |
| 1,3,5-Trimethylbenzene | 515 | 6.60 | 34.0 | 0.610 | 490 | 0.535 | 65.2 | 7,598 |
| 1,4-Dichlorobenzene | 1,329 | 0.677 | 9.00 | 0.450 | 110 | 0.649 | 6,900 | 20,000 |
| 2,4,5-T | 9 | 11.1 | 1.000 | 1.80 | 1.80 | 21 | 100 | 162 |
| 2,4,5-Trichlorophenol | 1,180 | 0.0847 | 1.000 | 1,100 | 1,100 | 330 | 34,000 | 4,000 |
| 2,4,6-Trichlorophenol | 1,180 | 0.0847 | 1.000 | 950 | 950 | 330 | 7,000 | 161 |
| 2,4,6-Trinitrotoluene | 8 | 12.5 | 1 | 56 | 56 | 0.220 | 250 | 283 |
| 2,4-DB | 9 | 0 | 0 | NA | NA | 83 | 100 | 426 |
| 2,4-Dichlorophenol | 1,180 | 0 | 0 | NA | NA | 330 | 7,000 | 2,744 |
| 2,4-Dinitrophenol | 1,173 | 0 | 0 | NA | NA | 850 | 35,000 | 20,000 |
| 2,4-Dinitrotoluene | 1,232 | 0 | 0 | NA | NA | 250 | 7,000 | 32.1 |
| 2,6-Dinitrotoluene | 1,232 | 0 | 0 | NA | NA | 250 | 7,000 | 6,186 |
| 2378-TCDD | 22 | 68.2 | 15.0 | 2.59E-05 | 0.00680 | 2.20E-04 | 0.00106 | 0.00425 |
| 2-Butanone | 631 | 2.54 | 16.0 | 3 | 155 | 2.72 | 1,400 | 1.07E+06 |
| 2-Chlorophenol | 1,180 | 0 | 0 | NA | NA | 330 | 7,000 | 281 |
| 2-Methylnaphthalene | 1,223 | 6.95 | 85.0 | 34 | 12,000 | 330 | 7,000 | 2,769 |
| 2-Methylphenol | 1,180 | 0 | 0 | NA | NA | 330 | 7,000 | 123,842 |
| 2-Nitroaniline | 1,224 | 0 | 0 | NA | NA | 370 | 35,000 | 5,659 |
| 4,4'-DDD | 468 | 0.427 | 2.00 | 3.50 | 10 | 1.80 | 190 | 13,726 |

**Table A1.4**
**Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level**

| Analyte | Total Number of Results | Detection Frequency (%) | Number of Detects | Minimum Detected Conc. | Maximum Detected Conc. | Minimum Nondetected Result | Maximum Nondetected Result | Minimum ESL |
|---|---|---|---|---|---|---|---|---|
| 4,4'-DDE | 468 | 1.50 | 7.00 | 0.600 | 7.20 | 1.80 | 190 | 7.95 |
| 4,4'-DDT | 468 | 0.855 | 4.00 | 9.10 | 26 | 1.80 | 190 | 1.20 |
| 4,6-Dinitro-2-methylphenol | 1,176 | 0.0850 | 1.000 | 390 | 390 | 850 | 35,000 | 560 |
| 4-Chloroaniline | 1,217 | 0 | 0 | NA | NA | 330 | 14,000 | 716 |
| 4-Methyl-2-pentanone | 630 | 2.38 | 15.0 | 4 | 73 | 1.94 | 2,960 | 14,630 |
| 4-Nitroaniline | 1,218 | 0.328 | 4.00 | 62 | 820 | 850 | 55,000 | 41,050 |
| 4-Nitrophenol | 1,169 | 0.171 | 2.00 | 53 | 320 | 850 | 35,000 | 7,000 |
| 4-Nitrotoluene | 5 | 0 | 0 | NA | NA | 250 | 250 | 61,422 |
| Acenaphthene | 1,239 | 22.3 | 276 | 21 | 44,000 | 330 | 6,900 | 20,000 |
| Acetone | 632 | 19.3 | 122 | 1.70 | 1,280 | 2.65 | 2,960 | 6,182 |
| Aldrin | 468 | 0.855 | 4.00 | 0.590 | 17 | 1.80 | 95 | 47.0 |
| alpha-BHC | 468 | 0.214 | 1.000 | 7.90 | 7.90 | 1.80 | 95 | 18,662 |
| alpha-Chlordane | 433 | 0 | 0 | NA | NA | 1.80 | 950 | 289 |
| Benzene | 633 | 0.948 | 6.00 | 1 | 11 | 0.502 | 680 | 500 |
| Benzo(a)pyrene | 1,235 | 41.2 | 509 | 36 | 43,000 | 19 | 7,000 | 631 |
| Benzyl Alcohol | 1,114 | 0.718 | 8.00 | 140 | 2,800 | 330 | 14,000 | 4,403 |
| beta-BHC | 467 | 0.428 | 2.00 | 11 | 11 | 1.80 | 95 | 207 |
| beta-Chlordane | 411 | 0.243 | 1.000 | 2.60 | 2.60 | 1.80 | 950 | 289 |
| bis(2-ethylhexyl)phthalate | 1,227 | 29.7 | 365 | 29 | 75,000 | 330 | 7,000 | 137 |
| Bromodichloromethane | 633 | 0 | 0 | NA | NA | 0.502 | 680 | 5,750 |
| Bromoform | 633 | 0 | 0 | NA | NA | 0.525 | 680 | 2,855 |
| Butylbenzylphthalate | 1,226 | 9.79 | 120 | 35 | 7,100 | 330 | 7,000 | 24,155 |
| Carbon Disulfide | 633 | 0.158 | 1.000 | 4 | 4 | 0.535 | 680 | 5,676 |
| Carbon Tetrachloride | 633 | 3.32 | 21.0 | 0.340 | 103 | 0.575 | 680 | 8,906 |
| Chlordane | 34 | 0 | 0 | NA | NA | 18 | 220 | 289 |
| Chlorobenzene | 633 | 0.316 | 2.00 | 2 | 2.03 | 0.484 | 680 | 4,750 |
| Chloroform | 633 | 1.11 | 7.00 | 1.30 | 7 | 0.543 | 680 | 8,655 |
| cis-1,2-Dichloroethene | 517 | 1.74 | 9.00 | 1.10 | 15 | 0.502 | 590 | 1,814 |
| cis-1,3-Dichloropropene | 633 | 0 | 0 | NA | NA | 0.502 | 680 | 2,800 |

**Table A1.4**
**Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level**

| Analyte | Total Number of Results | Detection Frequency (%) | Number of Detects | Minimum Detected Conc. | Maximum Detected Conc. | Minimum Nondetected Result | Maximum Nondetected Result | Minimum ESL |
|---|---|---|---|---|---|---|---|---|
| delta-BHC | 468 | 0.214 | 1.000 | 23 | 23 | 1.80 | 95 | 25.9 |
| Dibenzofuran | 1,227 | 10.9 | 134 | 36 | 20,000 | 330 | 7,000 | 21,200 |
| Dibromochloromethane | 633 | 0 | 0 | NA | NA | 0.502 | 680 | 5,730 |
| Dicamba | 9 | 55.6 | 5.00 | 2.30 | 150 | 42 | 100 | 1,690 |
| Dichlorodifluoromethane | 499 | 0 | 0 | NA | NA | 1.73 | 398 | 855 |
| Dieldrin | 468 | 2.35 | 11.0 | 1.80 | 92 | 1.80 | 190 | 7.40 |
| Diethylphthalate | 1,224 | 0.654 | 8.00 | 33 | 420 | 330 | 7,000 | 100,000 |
| Dimethoate | 7 | 0 | 0 | NA | NA | 18 | 180 | 13.7 |
| Dimethylphthalate | 1,227 | 1.47 | 18.0 | 69 | 460 | 330 | 7,000 | 200,000 |
| Di-n-butylphthalate | 1,227 | 7.99 | 98.0 | 35 | 10,000 | 330 | 7,000 | 15.9 |
| Di-n-octylphthalate | 1,225 | 3.92 | 48.0 | 38 | 11,000 | 330 | 7,000 | 731,367 |
| Endosulfan I | 468 | 0.427 | 2.00 | 3.90 | 7.40 | 1.80 | 95 | 80.1 |
| Endosulfan II | 461 | 0.651 | 3.00 | 0.700 | 9.90 | 1.80 | 170 | 80.1 |
| Endosulfan sulfate | 468 | 0.641 | 3.00 | 5.50 | 24 | 1.80 | 190 | 80.1 |
| Endrin | 468 | 1.28 | 6.00 | 2.40 | 17 | 1.80 | 200 | 1.40 |
| Endrin aldehyde | 66 | 3.03 | 2.00 | 8.70 | 9.20 | 1.80 | 38 | 1.40 |
| Endrin ketone | 437 | 0.229 | 1.000 | 36 | 36 | 1.80 | 190 | 1.40 |
| Fluorene | 1,244 | 18.8 | 234 | 27 | 39,000 | 140 | 7,000 | 30,000 |
| gamma-BHC (Lindane) | 468 | 0.214 | 1.000 | 8.30 | 8.30 | 1.80 | 95 | 25.9 |
| gamma-Chlordane | 23 | 0 | 0 | NA | NA | 2 | 260 | 289 |
| Heptachlor | 468 | 0 | 0 | NA | NA | 1.80 | 95 | 63.3 |
| Heptachlor epoxide | 467 | 0.642 | 3.00 | 7.20 | 23 | 1.80 | 95 | 64.0 |
| Hexachlorobenzene | 1,224 | 0.327 | 4.00 | 110 | 380 | 330 | 7,000 | 7.73 |
| Hexachlorobutadiene | 1,550 | 0.0645 | 1.000 | 2.20 | 2.20 | 0.508 | 7,000 | 431 |
| Hexachlorocyclopentadiene | 1,208 | 0 | 0 | NA | NA | 330 | 7,000 | 5,518 |
| Hexachloroethane | 1,227 | 0 | 0 | NA | NA | 330 | 7,000 | 366 |
| HMX | 5 | 20 | 1 | 230 | 230 | 250 | 250 | 16,012 |
| Methoxychlor | 468 | 1.71 | 8.00 | 0.280 | 450 | 3.50 | 950 | 1,226 |
| Methylene Chloride | 631 | 12.0 | 76.0 | 0.790 | 45 | 0.502 | 2,200 | 3,399 |

**Table A1.4**
**Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level**

| Analyte | Total Number of Results | Detection Frequency (%) | Number of Detects | Minimum Detected Conc. | Maximum Detected Conc. | Minimum Nondetected Result | Maximum Nondetected Result | Minimum ESL |
|---|---|---|---|---|---|---|---|---|
| Naphthalene | 1,567 | 14.1 | 221 | 0.850 | 41,000 | 0.751 | 7,000 | 27,048 |
| Nitrobenzene | 1,218 | 0 | 0 | NA | NA | 250 | 7,000 | 40,000 |
| N-nitrosodiphenylamine | 1,227 | 0 | 0 | NA | NA | 330 | 7,000 | 20,000 |
| PCB-1016 | 795 | 0.755 | 6.00 | 13 | 95 | 33 | 4,500 | 172 |
| PCB-1221 | 845 | 0 | 0 | NA | NA | 33 | 4,500 | 172 |
| PCB-1232 | 845 | 0 | 0 | NA | NA | 33 | 4,500 | 172 |
| PCB-1242 | 845 | 0.237 | 2.00 | 23 | 350 | 33 | 4,500 | 172 |
| PCB-1248 | 845 | 0.710 | 6.00 | 17 | 840 | 33 | 4,500 | 172 |
| PCB-1254 | 842 | 17.9 | 151 | 6.80 | 8,900 | 33 | 9,000 | 172 |
| PCB-1260 | 838 | 17.2 | 144 | 6.20 | 7,800 | 33 | 4,300 | 172 |
| Pentachlorophenol | 1,180 | 1.02 | 12.0 | 39 | 39,000 | 850 | 35,000 | 122 |
| Phenol | 1,180 | 0.424 | 5.00 | 33 | 130 | 330 | 7,000 | 23,090 |
| Styrene | 633 | 0.158 | 1.000 | 7.80 | 7.80 | 0.550 | 680 | 16,408 |
| Tetrachloroethene | 633 | 8.53 | 54.0 | 0.380 | 29,000 | 0.641 | 680 | 763 |
| Toluene | 633 | 9.00 | 57.0 | 0.0990 | 990 | 0.528 | 60.8 | 14,416 |
| Toxaphene | 468 | 0 | 0 | NA | NA | 86 | 2,200 | 3,756 |
| trans-1,2-Dichloroethene | 532 | 0 | 0 | NA | NA | 0.738 | 93.3 | 25,617 |
| trans-1,3-Dichloropropene | 633 | 0 | 0 | NA | NA | 0.502 | 680 | 2,800 |
| Trichloroethene | 633 | 4.11 | 26.0 | 0.170 | 200 | 0.500 | 680 | 389 |
| Vinyl acetate | 78 | 0 | 0 | NA | NA | 10 | 1,400 | 13,986 |
| Vinyl Chloride | 633 | 0 | 0 | NA | NA | 0.748 | 1,400 | 97.7 |
| Xylene | 633 | 10.4 | 66.0 | 0.600 | 933 | 0.502 | 680 | 1,140 |

NA = Not applicable.

**Table A1.5**
**Summary of Professional Judgment and Ecological Risk Potential**

| ANALYTE | SUMMARY OF PROFESSIONAL JUDGMENT | | | | | | | | ECOLOGICAL RISK POTENTIAL | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Listed as Waste Constituent for WBEU Historical IHSSs ?[1] | Historical RFETS Inventory [2] (1974/1988) (kg) | Maximum Conc. in Soil Sitewide (ug/kg) | Detection Frequency in Sitewide Soil (%) | Maximum Conc. in WBEUU Soil (ug/kg) | Detection Frequency in WBEU Soil (%) | Potential to be an ECOPC? | Uncertainty Category[3] | Lowest ESL (ug/kg) | Most Sensitive Receptor [4] | LOAEL/ NOAEL [5] | LOAEL-Based Soil Conc. (ug/kg) | Maximum Reported Result for Non-detects in WBEU (ug/kg) | Maximum Reported Result/ LOAEL-Based Soil Conc. [6] | Potential for Adverse Effects if Detected at Maximum Reported Result Level? |
| 2,4,6-Trichlorophenol | No | 0/.01 | 950 | 0.1 | N/A | 0 | No | 2 | 160.5 | Deer Mouse Insectivore | 100 | 16050 | 820 | 0.05 | No |
| 2,4-Dinitrotoluene | No | 0/0 | N/A | 0 | N/A | 0 | No | 1 | 32.1 | Deer Mouse Insectivore | 10 | 3210 | 820 | 0.3 | No |
| 2-Chlorophenol | No | 0.12/0.02 | N/A | 0 | N/A | 0 | No | 1 | 281 | Deer Mouse Insectivore | 100 | 28100 | 820 | 0.03 | No |
| 4,4'-DDT | No | 0/0.001 | 26 | 0.9 | N/A | 0 | No | 2 | 1.20 | Mourning Dove Insectivore | 167 | 200 | 22 | 0.1 | No |
| 4,6-Dinitro-2-methylphenol | No | 0/0 | 390 | 0.1 | 390 | 1.25 | No | 3 | 560 | Deer Mouse Insectivore | 20 | 11200 | 4,100 | 0.4 | No |
| Di-n-butylphthalate | Yes(1) | 0/0.005 | 10000 | 8.0 | 1000 | 1.18 | Yes | 4 | 15.9 | Mourning Dove Insectivore | 10 | 159 | 820 | 5 | Yes |
| Endrin aldehyde | No | 0/0.002 | 9.2 | 3.0 | N/A | 0 | No | 2 | 1.40 | Mourning Dove Insectivore | 10 | 14 | 9.80 | 0.7 | No |
| Endrin ketone | No | 0/0 | 36 | 0.2 | N/A | 0 | No | 2 | 1.40 | Mourning Dove Insectivore | 10 | 14 | 21 | 2 | Yes |
| Hexachlorobenzene | No | 1.000/1.005 | 380 | 0.3 | N/A | 0 | No | 2 | 7.73 | Mourning Dove Insectivore | 40 | 309 | 820 | 3 | Yes |
| Pentachlorophenol | No | 0.02/0.02 | 39000 | 1.0 | N/A | 0 | No | 2 | 122 | Deer Mouse Insectivore | 10 | 1220 | 4,100 | 3 | Yes |

[1] Includes listing of the class of compound, e.g., herbicides, pesticides, chlorinated solvents, polynuclear aromatic hydrocarbons, etc. Ref. DOE, 2005a.
[2] CDH, 1991.
[3] See text for explanation.
[4] Basis for the lowest ESL.
[5] LOAELs and NOAELs from Appendix B, Table B-2, "TRVs for Terrestrial Vertebrate Receptors", Ref. DOE 2005b.
[6] Ratios are rounded to one significant figure.
(1) Drums of radionuclide contaminated oil were stored at PAC 900-112 (903 Pad), and oils were spayed on PAC 000-501 (Roadway Spraying). The oils could contain phthalates.
CDH – Colorado Department of Health
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
DOE – Department of Energy
ECOPC – Ecological Contaminant of Potential Concern
ESL – Ecological Screening Level
IHSS – Individual Hazardous Substance Site
LOAEL – Lowest Bounded Lowest Observed Adverse Effect Level
NOAEL - Final No Observed Adverse Effect Level
RFETS – Rocky Flats Environmental Technology Site
WBEU – Wind Blown Exposure Unit
NA – Not applicable
NVA – No Value Available
I- Inconclusive

**Table A1.6**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | Lowest ESL | Number of Nondetected Results > ESL | Percent Nondetected Results > ESL | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| **Inorganic (mg/kg)** | | | | | | | | |
| Cyanide | 0.0442 | - | 0.640 | 67 | 2,200 | 0 | 0 | No |
| Selenium | 0.200 | - | 49.1 | 295 | 2.80 | 1 | 0.339 | Yes |
| **Organic (ug/kg)** | | | | | | | | |
| 1,1,1,2-Tetrachloroethane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| 1,1,1-Trichloroethane | 0.778 | - | 5,500 | 484 | 4.85E+07 | 0 | 0 | Yes |
| 1,1,2,2-Tetrachloroethane | 0.522 | - | 5,500 | 483 | 4.70E+06 | 0 | 0 | Yes |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.888 | - | 5,500 | 283 | | 0 | 0 | Yes |
| 1,1,2-Trichloroethane | 0.497 | - | 5,500 | 495 | | 0 | 0 | No |
| 1,1-Dichloroethane | 0.507 | - | 5,500 | 490 | 215,360 | 0 | 0 | No |
| 1,1-Dichloroethene | 0.632 | - | 5,500 | 488 | 1.28E+06 | 0 | 0 | Yes |
| 1,1-Dichloropropene | 1.01 | - | 5,500 | 279 | | 0 | 0 | No |
| 1,2,3-Trichlorobenzene | 0.637 | - | 5,500 | 274 | | 0 | 0 | Yes |
| 1,2,3-Trichloropropane | 0.938 | - | 5,500 | 279 | 1.17E+06 | 0 | 0 | No |
| 1,2,4,5-Tetrachlorobenzene | 340 | - | 3,600 | 53 | | 0 | 0 | No |
| 1,2,4-Trichlorobenzene | 0.753 | - | 3,600 | 406 | 94,484 | 0 | 0 | Yes |
| 1,2,4-Trimethylbenzene | 0.586 | - | 5,500 | 266 | | 0 | 0 | Yes |
| 1,2-Dibromo-3-chloropropane | 1.36 | - | 5,500 | 279 | | 0 | 0 | No |
| 1,2-Dibromoethane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| 1,2-Dichlorobenzene | 0.497 | - | 3,600 | 413 | | 0 | 0 | Yes |
| 1,2-Dichloroethane | 0.517 | - | 5,500 | 488 | 2.00E+06 | 0 | 0 | No |
| 1,2-Dichloroethene | 5 | - | 1,500 | 151 | 1.87E+06 | 0 | 0 | Yes |
| 1,2-Dichloropropane | 0.497 | - | 5,500 | 490 | 3.92E+06 | 0 | 0 | No |
| 1,2-Diphenylhydrazine | 340 | - | 3,600 | 53 | | 0 | 0 | No |
| 1,3,5-Trimethylbenzene | 0.530 | - | 5,500 | 274 | 855,709 | 0 | 0 | Yes |
| 1,3-Dichlorobenzene | 0.500 | - | 3,600 | 409 | | 0 | 0 | Yes |
| 1,3-Dichloropropane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| 1,4-Dichlorobenzene | 0.924 | - | 3,600 | 407 | 5.93E+06 | 0 | 0 | Yes |
| 1,4-Dioxane | 103 | - | 114 | 5 | 719,409 | 0 | 0 | No |
| 2,2-Dichloropropane | 0.720 | - | 5,500 | 279 | | 0 | 0 | No |
| 2,4,5-T | 21 | - | 22 | 5 | 16,560 | 0 | 0 | No |
| 2,4,5-TP (Silvex) | 21 | - | 22 | 5 | | 0 | 0 | No |
| 2,4,5-Trichlorophenol | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 2,4,6-Trichlorophenol | 330 | - | 77,000 | 249 | 17,263 | 1 | 0.402 | No |
| 2,4-D | 83 | - | 87 | 5 | | 0 | 0 | No |
| 2,4-DB | 83 | - | 87 | 5 | 47,561 | 0 | 0 | No |
| 2,4-Dichlorophenol | 330 | - | 77,000 | 249 | 249,324 | 0 | 0 | No |
| 2,4-Dimethylphenol | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 2,4-Dinitrophenol | 1,600 | - | 380,000 | 249 | 4.90E+06 | 0 | 0 | No |
| 2,4-Dinitrotoluene | 330 | - | 77,000 | 249 | 2,473 | 6 | 2.41 | No |
| 2,6-Dinitrotoluene | 330 | - | 77,000 | 249 | 477,309 | 0 | 0 | No |
| 2-Chloroethyl vinyl ether | 10 | - | 1,600 | 59 | | 0 | 0 | No |
| 2-Chloronaphthalene | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 2-Chlorophenol | 330 | - | 77,000 | 248 | 21,598 | 1 | 0.403 | Yes |
| 2-Chlorotoluene | 0.528 | - | 5,500 | 279 | | 0 | 0 | No |
| 2-Hexanone | 5 | - | 22,000 | 469 | | 0 | 0 | Yes |
| 2-Methyl-1-propanol | 103 | - | 114 | 5 | | 0 | 0 | No |
| 2-Methylnaphthalene | 330 | - | 3,900 | 244 | 319,121 | 0 | 0 | Yes |
| 2-Methylphenol | 330 | - | 77,000 | 254 | 9.26E+06 | 0 | 0 | No |
| 2-Nitroaniline | 360 | - | 380,000 | 249 | 418,475 | 0 | 0 | No |
| 2-Nitrophenol | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 3 & 4-methyl phenol | 1,010 | - | 1,080 | 5 | | 0 | 0 | No |
| 3,3'-Dichlorobenzidine | 680 | - | 150,000 | 240 | | 0 | 0 | No |
| 3-Nitroaniline | 380 | - | 380,000 | 243 | | 0 | 0 | No |

**Table A1.6**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | Lowest ESL | Number of Nondetected Results > ESL | Percent Nondetected Results > ESL | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| 4,4'-DDD | 3.60 | - | 1,190 | 81 | 6.19E+06 | 0 | 0 | No |
| 4,4'-DDE | 3.60 | - | 430 | 81 | 54,420 | 0 | 0 | No |
| 4,4'-DDT | 3.60 | - | 1,270 | 81 | 175,708 | 0 | 0 | No |
| 4,6-Dinitro-2-methylphenol | 1,600 | - | 380,000 | 249 | 44,283 | 1 | 0.402 | No |
| 4-Bromophenyl-phenylether | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 4-Chloro-3-methylphenol | 330 | - | 150,000 | 248 | | 0 | 0 | Yes |
| 4-Chloroaniline | 330 | - | 150,000 | 249 | 48,856 | 1 | 0.402 | No |
| 4-Chlorophenyl-phenyl ether | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 4-Chlorotoluene | 0.837 | - | 5,500 | 279 | | 0 | 0 | No |
| 4-Isopropyltoluene | 0.609 | - | 5,500 | 276 | | 0 | 0 | Yes |
| 4-Methyl-2-pentanone | 5 | - | 22,000 | 474 | 859,131 | 0 | 0 | Yes |
| 4-Methylphenol | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| 4-Nitroaniline | 1,600 | - | 380,000 | 245 | 2.62E+06 | 0 | 0 | No |
| 4-Nitrophenol | 390 | - | 380,000 | 249 | 1.02E+06 | 0 | 0 | No |
| Acenaphthene | 330 | - | 3,900 | 243 | | 0 | 0 | Yes |
| Acenaphthylene | 330 | - | 38,000 | 248 | | 0 | 0 | Yes |
| Acetonitrile | 103 | - | 114 | 5 | | 0 | 0 | No |
| Aldrin | 1.80 | - | 430 | 81 | 11,282 | 0 | 0 | No |
| alpha-BHC | 1.80 | - | 318 | 81 | 2.47E+06 | 0 | 0 | No |
| alpha-Chlordane | 1.80 | - | 1,700 | 76 | 472,808 | 0 | 0 | No |
| Anthracene | 330 | - | 3,900 | 241 | | 0 | 0 | Yes |
| Benzene | 0.497 | - | 5,500 | 494 | 1.10E+06 | 0 | 0 | Yes |
| Benzo(b)fluoranthene | 330 | - | 77,000 | 239 | | 0 | 0 | Yes |
| Benzo(k)fluoranthene | 330 | - | 77,000 | 243 | | 0 | 0 | Yes |
| Benzyl Alcohol | 330 | - | 150,000 | 249 | 253,015 | 0 | 0 | No |
| beta-BHC | 1.80 | - | 637 | 81 | 27,399 | 0 | 0 | No |
| beta-Chlordane | 1.80 | - | 1,700 | 76 | 472,808 | 0 | 0 | No |
| bis(2-Chloroethoxy) methane | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| bis(2-Chloroethyl) ether | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| bis(2-Chloroisopropyl) ether | 330 | - | 77,000 | 246 | | 0 | 0 | No |
| Bromobenzene | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| Bromochloromethane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| Bromodichloromethane | 0.497 | - | 5,500 | 490 | 381,135 | 0 | 0 | No |
| Bromoform | 0.594 | - | 5,500 | 484 | 198,571 | 0 | 0 | No |
| Bromomethane | 0.963 | - | 5,500 | 485 | | 0 | 0 | No |
| Carbon Disulfide | 0.888 | - | 15,000 | 489 | 410,941 | 0 | 0 | Yes |
| Carbon Tetrachloride | 0.849 | - | 5,500 | 478 | 736,154 | 0 | 0 | Yes |
| Chlordane | 290 | - | 1,510 | 5 | 472,808 | 0 | 0 | No |
| Chlorobenzene | 0.497 | - | 5,500 | 495 | 413,812 | 0 | 0 | No |
| Chloroethane | 1.08 | - | 5,500 | 487 | | 0 | 0 | No |
| Chloromethane | 1.01 | - | 5,500 | 485 | | 0 | 0 | No |
| cis-1,3-Dichloropropene | 0.497 | - | 5,500 | 490 | 222,413 | 0 | 0 | No |
| Dalapon | 42 | - | 44 | 5 | | 0 | 0 | No |
| delta-BHC | 1.80 | - | 952 | 81 | 3,425 | 0 | 0 | No |
| Dibenz(a,h)anthracene | 330 | - | 77,000 | 247 | | 0 | 0 | Yes |
| Dibenzofuran | 330 | - | 3,900 | 248 | 2.44E+06 | 0 | 0 | Yes |
| Dibromochloromethane | 0.497 | - | 5,500 | 490 | 389,064 | 0 | 0 | No |
| Dibromomethane | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| Dichlorodifluoromethane | 1.72 | - | 5,500 | 279 | 59,980 | 0 | 0 | No |
| Dichloroprop | 83 | - | 87 | 5 | | 0 | 0 | No |
| Dieldrin | 3.60 | - | 340 | 81 | 301 | 1 | 1.23 | No |
| Diethylphthalate | 340 | - | 77,000 | 248 | 2.21E+08 | 0 | 0 | Yes |
| Dimethylphthalate | 330 | - | 77,000 | 249 | 1.35E+07 | 0 | 0 | No |
| Di-n-octylphthalate | 330 | - | 77,000 | 249 | 2.58E+08 | 0 | 0 | No |

**Table A1.6**
**Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil in the WBEU**

| Analyte | Range of Nondetected Reported Results | | | Total Number of Nondetected Results | Lowest ESL | Number of Nondetected Results > ESL | Percent Nondetected Results > ESL | Analyte Detected? |
|---|---|---|---|---|---|---|---|---|
| Dinoseb | 12 | - | 13 | 5 | | 0 | 0 | No |
| Endosulfan I | 1.80 | - | 222 | 81 | 8,726 | 0 | 0 | No |
| Endosulfan II | 3.60 | - | 430 | 80 | 8,726 | 0 | 0 | No |
| Endosulfan sulfate | 3.60 | - | 7,140 | 81 | 8,726 | 0 | 0 | No |
| Endrin | 3.60 | - | 637 | 81 | 8,060 | 0 | 0 | No |
| Endrin aldehyde | 3.60 | - | 2,460 | 9 | 8,060 | 0 | 0 | No |
| Endrin ketone | 3.60 | - | 340 | 76 | 8,060 | 0 | 0 | No |
| Ether | 52.3 | - | 57 | 3 | 1.68E+06 | 0 | 0 | No |
| ethyl acetate | 51.3 | - | 57 | 5 | 3.14E+06 | 0 | 0 | No |
| Ethylbenzene | 0.497 | - | 5,500 | 491 | | 0 | 0 | Yes |
| Fluorene | 330 | - | 3,900 | 245 | | 0 | 0 | Yes |
| gamma-BHC (Lindane) | 1.80 | - | 430 | 81 | 3,425 | 0 | 0 | No |
| Heptachlor | 1.80 | - | 318 | 81 | 12,359 | 0 | 0 | No |
| Heptachlor epoxide | 1.80 | - | 857 | 81 | 9,121 | 0 | 0 | No |
| Hexachlorobenzene | 330 | - | 77,000 | 249 | 190,142 | 0 | 0 | No |
| Hexachlorobutadiene | 0.639 | - | 3,600 | 407 | 150,894 | 0 | 0 | Yes |
| Hexachlorocyclopentadiene | 340 | - | 77,000 | 249 | 799,679 | 0 | 0 | No |
| Hexachloroethane | 330 | - | 77,000 | 249 | 45,656 | 1 | 0.402 | No |
| Indeno(1,2,3-cd)pyrene | 330 | - | 77,000 | 240 | | 0 | 0 | Yes |
| Isophorone | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| Isopropylbenzene | 0.497 | - | 5,500 | 279 | | 0 | 0 | No |
| MCPA | 8,300 | - | 8,700 | 5 | | 0 | 0 | No |
| MCPP | 8,300 | - | 8,700 | 5 | | 0 | 0 | No |
| Methoxychlor | 18 | - | 19,100 | 81 | 228,896 | 0 | 0 | No |
| n-Butanol | 103 | - | 114 | 5 | | 0 | 0 | No |
| n-Butylbenzene | 0.705 | - | 5,500 | 278 | | 0 | 0 | Yes |
| Nitrobenzene | 330 | - | 77,000 | 254 | | 0 | 0 | No |
| N-Nitrosodiethylamine | 680 | - | 7,300 | 53 | | 0 | 0 | No |
| N-Nitrosodimethylamine | 680 | - | 7,300 | 53 | | 0 | 0 | No |
| N-Nitrosodi-n-butylamine | 340 | - | 3,600 | 53 | | 0 | 0 | No |
| N-Nitroso-di-n-propylamine | 330 | - | 77,000 | 249 | | 0 | 0 | No |
| N-nitrosodiphenylamine | 330 | - | 3,900 | 246 | 2.15E+06 | 0 | 0 | Yes |
| n-Propylbenzene | 0.664 | - | 5,500 | 279 | | 0 | 0 | No |
| o-Xylene | 6 | - | 6 | 1 | 111,663 | 0 | 0 | No |
| PCB-1016 | 33 | - | 21,700 | 189 | 37,963 | 0 | 0 | No |
| PCB-1221 | 33 | - | 21,700 | 189 | 37,963 | 0 | 0 | No |
| PCB-1232 | 33 | - | 21,700 | 189 | 37,963 | 0 | 0 | No |
| PCB-1242 | 33 | - | 21,700 | 189 | 37,963 | 0 | 0 | No |
| PCB-1248 | 33 | - | 21,700 | 188 | 37,963 | 0 | 0 | Yes |
| PCB-1260 | 21 | - | 3,400 | 182 | 37,963 | 0 | 0 | Yes |
| Pentachlorobenzene | 340 | - | 3,600 | 53 | 68,375 | 0 | 0 | No |
| Pentachlorophenol | 1,600 | - | 380,000 | 248 | 18,373 | 2 | 0.806 | Yes |
| Pyridine | 680 | - | 77,000 | 35 | | 0 | 0 | No |
| sec-Butylbenzene | 0.613 | - | 5,500 | 279 | | 0 | 0 | No |
| Styrene | 0.545 | - | 5,500 | 488 | 1.53E+06 | 0 | 0 | Yes |
| tert-Butylbenzene | 0.709 | - | 5,500 | 279 | | 0 | 0 | No |
| Toxaphene | 86 | - | 27,000 | 81 | 909,313 | 0 | 0 | No |
| trans-1,2-Dichloroethene | 0.732 | - | 2,800 | 335 | 1.87E+06 | 0 | 0 | No |
| trans-1,3-Dichloropropene | 0.497 | - | 5,500 | 486 | 222,413 | 0 | 0 | No |
| Trichlorofluoromethane | 1.17 | - | 5,500 | 284 | | 0 | 0 | No |
| Vinyl acetate | 6 | - | 7,800 | 195 | 730,903 | 0 | 0 | No |
| Vinyl Chloride | 0.980 | - | 5,500 | 490 | 6,494 | 0 | 0 | No |

# COMPREHENSIVE RISK ASSESSMENT

# WIND BLOWN EXPOSURE UNIT

## VOLUME 9: ATTACHMENT 2

## Data Quality Assessment

## TABLE OF CONTENTS



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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AA | atomic absorption |
| ASD | Analytical Services Division |
| COC | contaminant of concern |
| CRA | Comprehensive Risk Assessment |
| CRDL | contract required detection limit |
| DAR | data adequacy report |
| DER | duplicate error ratio |
| DOE | U.S. Department of Energy |
| DQA | Data Quality Assessment |
| DQO | data quality objective |
| DRC | data review checklist |
| ECOPC | ecological contaminant of potential concern |
| EDD | electronic data deliverable |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| EU | exposure unit |
| FD | field duplicate |
| IAG | Interagency Agreement |
| ICP | inductively couple plasma |
| IDL | instrument detection limit |
| LCS | laboratory control sample |
| MDA | minimum detectable activity |
| MDL | method detection limit |

| | |
|---|---|
| MS | matrix spike |
| MSA | method of standard additions |
| MSD | matrix spike duplicate |
| N/A | not applicable |
| PARCC | precision, accuracy, representativeness, completeness, and comparability |
| PPT | Pipette |
| PCB | polychlorinated biphenyl |
| QC | quality control |
| RDL | required detection limit |
| RFETS | Rocky Flats Environmental Technology Site |
| RI/FS | Remedial Investigation/Feasibility Study |
| RL | reporting limit |
| RPD | relative percent difference |
| SDP | standard data package |
| SOW | Statement of Work |
| SVOC | semi-volatile organic compound |
| SWD | Soil Water Database |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TIC | tentatively identified compound |
| V&V | verification and validation |
| VOC | volatile organic compound |
| WBEU | Wind Blown Exposure Unit |

# 1.0 INTRODUCTION

This document provides an assessment of the quality of the data used in the human health and ecological risk assessments for the Wind Blown Exposure Unit (WBEU). The data quality was evaluated against standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters by the data validator under the multiple work plans that guided the data collection over the past 15 years, as well as the requirements for the PARCC parameters provided in the Comprehensive Risk Assessment (CRA) Methodology (DOE 2005). The details of this data quality assessment (DQA) process are presented in the Sitewide DQA contained in Appendix A, Volume 2, Attachment 2 of the Remedial Investigation/Feasibility Study (RI/FS).

Of the 447,516 environmental sampling records in the RFETS database associated with the WBEU, 214,632 were used in the WBEU risk assessment based on the data processing rules described in Section 2.0 of the Sitewide DQA. Of the 214,632 analytical records existing in the WBEU CRA data set, 91 percent (195,609 records) have undergone verification or validation (V&V) (Table A2.1). The V&V review involved applying observation notes and qualifiers flags or observation notes without qualifier flags to the data.

PARCC parameter analysis was used to determine if the data quality could affect the risk assessment decisions (i.e., have significant impact on risk assessment calculations or selection of contaminants of concern [COCs] for human health or ecological contaminants of potential concern [ECOPCs]). In consultation with the data users and project team, the primary ways in which the PARCC parameters could impact the risk decisions were identified and these include the following:

- Detect results are falsely identified as nondetects;
- Nondetect results are falsely identified as detects;
- Issues that cause detection limit uncertainty;
- Issues that cause significant overestimation of detect results; and
- Issues that cause significant underestimation of detect results.

# 2.0 SUMMARY OF FINDINGS

## 2.1 PARCC Findings

A summary of V&V observations and the associated, affected PARCC parameter is presented in Table A2.2 by analyte group and matrix (i.e., “soil” includes soil and sediment, and “water” includes surface water and groundwater). Table A2.3 presents the percentage of the WBEU V&V data that were qualified as estimated and/or undetected by analyte group and matrix. Overall, approximately 12 percent of the WBEU CRA data were qualified as estimated or undetected. Less than 3 percent of the data reported as detected by the laboratory were qualified as undetected by the validator due to blank contamination (Table A2.4). In general, data qualified as estimated or undetected are marked as such because of various laboratory noncompliance issues that are not serious enough to render the data unusable. The precision between field duplicate (FD)/target sample analyte pairs is summarized in Table A2.5.

Of the 91 percent of the WBEU that underwent V&V, 85 percent were qualified as having no QC issues, and approximately 12 percent were qualified as estimated or undetected (Table A2.3). The remaining 3 percent of the V&V data are made up of records qualified with additional flags indicating acceptable and non-estimated data such as “A”, “C”, or “E”.

Less than 3 percent of the entire data set was rejected during the V&V process (Table A2.6). Rejected data were removed from the WBEU CRA data set during the data processing as defined in Section 2.0 of the Sitewide DQA.

The general discussion below summarizes the data quality as presented by the data validator’s observations. The relationship between these observations and the PARCC parameters can be found in the Sitewide DQA. Several observations have no impact on data quality because they represent issues that were noted but corrected, or represent other, general observations such as missing documentation that was not required for data assessment. Approximately 21 percent of the WBEU V&V data were marked with these V&V observations that have no affect on any of the PARCC parameters.

Of the V&V data, approximately 2 percent was noted for observations related to precision. Of that 2 percent, 99 percent contained issues related to sample matrices. Result confirmation and instrument setup observations make up the other 1 percent. No LCS or sensitivity issues related to precision were noted.

Of the V&V data, 32 percent was noted for accuracy-related observations. Of that 32 percent, 79 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 21 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that not all accuracy-related observations resulted in data qualification. Less than 13 percent of the WBEU CRA data set was qualified as estimated and/or undetected (Table A2.3).

The data were determined to meet the representativeness parameter because sampling locations are spatially distributed such that contaminant randomness and bias considerations are addressed based on the site-specific history (see the Data Adequacy Report [DAR] in Appendix A, Volume 2, Attachment 3). Samples were also analyzed by the SW-846 or alpha-spectroscopy methods and results were documented as quality records according to approved procedures and guidelines (V&V).

Of the V&V data, approximately 32 percent were noted for observations related to representativeness. Of that 32 percent, 63 percent was marked for blank observations, 25 percent for failure to observe allowed holding times, 3 percent for documentation issues, 6 percent for sample preparation observations, and 1 percent for instrument sensitivity issues. Matrix, LCS, instrument set-up, and other observations make up the other 2 percent of the data noted for observations related to sample representativeness. Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs and samples were generally stored and preserved properly.

The CRA Methodology specifies completeness criteria based on data adequacy and these criteria and the findings are discussed in the DAR in Appendix A, Volume 2, Attachment 3 of the RI/FS. Additionally, it should be noted that less than 3 percent of all V&V data associated with the WBEU were rejected.

Comparability of the WBEU CRA data set is ensured as all analytical results have been converted into common units. Comparability is addressed more specifically in Appendix A, Volume 2, Attachment 2 of the RI/FS.

## 2.2 PARCC Findings Potential Impact on Data Usability

PARCC parameter influence on data usability is discussed below with an emphasis on the RA decisions as defined in the Introduction to this document.

Table A2.3 summarizes the overall percentage of qualified data, independent of validation observation. The table is used for overall guidance in selecting analyte group and matrix combinations of interest in the analysis of the risk assessment decisions, the impact on data usability is better analyzed using Tables A2.5 through A2.7, as these can be more directly related to the 5 key risk assessment decision factors described in the introduction.

A summary of FD/target sample precision information can be found in Table A2.6. Where there are analyte group and matrix combinations failures in excess of 10 percent, the data must be reviewed to determine if there could be an impact on the results of the risk assessment.

Table A2.7 lists V&V observations where the number of observations by analyte group and matrix exceeds 5 percent of the associated records (see column “Percent Observed”) with the exception of those observations that were determined to have no impact on any of the PARCC parameters. Such observations are identified in Table A2.2 by an “Affected PARCC Parameter” of not applicable (N/A). Additionally the analyte group and matrix is broken down further in the columns “Percent Qualified U” and “Percent Qualified J”. Data qualifications that are considered to have potential impact on risk assessment decisions were reviewed and are discussed in detail in the bulleted list below. Other issues are not considered to have the potential for significant impacts on the results of the risk assessments because the uncertainty associated with these data quality issues is assumed to be less than the overall uncertainty in the risk assessment process (e.g., uncertainties such as exposure assumptions, toxicity values, and statistical methods for calculating exposure point concentrations).

Data qualifications associated with the water matrix are not discussed below. Surface water data are used in the ecological risk assessment for an EU only for those analytes identified as ECOPCs, and the surface water component of exposure contributes only minimally to the overall risk estimates. As described in the Sitewide DQA (Attachment 2 of Volume 2 of Appendix A of the RI/FS Report), groundwater data are not used in the ecological risk assessment and the groundwater evaluations for the human health portion of the risk assessment are performed on a sitewide basis. In addition, surface water is evaluated for the human health risk assessment on a sitewide basis. Therefore, data quality evaluations for groundwater and surface water are presented in the Sitewide DQA.

Issues that have the potential to impact the risk assessment decision include the following:

- Approximately 11 percent of all radionuclide/soil FD/target sample analyte pairs failed duplicate error ratio (DER) criteria (Table A2.5). Of the 50 records that did not meet DER criteria, 30 are plutonium-239/240 records. Plutonium-239/240 was selected as a COC for the human health risk assessment in the WBEU.

  All analytical results associated with the FD/target analyte pairs that failed DER criteria are within an order of magnitude of one another. The risk characterization determined radionuclide risk to be at the low end of the target risk range ($1 \times 10^{-6}$ to $1 \times 10^{-4}$) in the WBEU. As a result it has been determined that any data imprecision related to the failed DER criterion would not change risk assessment decisions. The radionuclide risk and the target risk range for the WBEU is discussed in further detail in Section 5.3 of the main text of this volume**.**

- Several V&V observations related to the wet chemistry/soil analyte group and matrix combination resulted in data qualifications in notable percentages of the data set (Table A2.7), it is important to note that this analyte group contains general chemistry parameters that are not directly related to site characterization. Therefore, the impact of these qualifications on risk assessment results is determined to be minimal.

## 3.0 CONCLUSIONS

This review concludes that the quality of the WBEU data is acceptable and the CRA objectives for PARCC performance have generally been met. Where either CRA Methodology or V&V guidance have not been met, the data are either flagged by the V&V process, or for those instances where the frequency of issues may influence the risk assessment decisions, the data quality issues were reviewed for magnitude of potential impact on risk assessment results.

Those elements of data quality that could potentially affect risk decisions in the WBEU have been analyzed and it was concluded that the noted deviations from the PARCC parameter criteria have minimal impact on risk assessment results related to the WBEU.

## 4.0 REFERENCES

DOE, 2002, Final Work Plan for the Development of the Remedial Investigation and Feasibility Study Report, Rocky Flats Environmental Technology Site, Golden, Colorado, March.

DOE, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1, September 2005.

# TABLES

**Table A2.1**
**CRA Data V&V Summary**

| Analyte Group | Matrix | Total No. of CRA V&V Records | Total No. of CRA Records | Percent V&V (%) |
|---|---|---|---|---|
| Dioxins and Furans | Water | 56 | 56 | 100.00 |
| Herbicide | Soil | 349 | 388 | 89.95 |
| Herbicide | Water | 95 | 96 | 98.96 |
| Metal | Soil | 12,381 | 13,569 | 91.24 |
| Metal | Water | 38,884 | 41,148 | 94.50 |
| PCB | Soil | 1,882 | 1,953 | 96.36 |
| PCB | Water | 455 | 462 | 98.48 |
| Pesticide | Soil | 2,688 | 2,937 | 91.52 |
| Pesticide | Water | 1,377 | 1,399 | 98.43 |
| Radionuclide | Soil | 3,541 | 4,159 | 85.14 |
| Radionuclide | Water | 9,345 | 10,838 | 86.22 |
| SVOC | Soil | 18,490 | 20,976 | 88.15 |
| SVOC | Water | 7,226 | 7,699 | 93.86 |
| VOC | Soil | 25,407 | 26,406 | 96.22 |
| VOC | Water | 67,249 | 75,972 | 88.52 |
| Wet Chem | Soil | 481 | 554 | 86.82 |
| Wet Chem | Water | 5,703 | 6,020 | 94.73 |
| | **Total** | **195,609** | **214,632** | **91.14%** |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Herbicide | Soil | Calibration | Continuing calibration verification criteria were not met | No | 28 | 349 | 8.02 | Accuracy |
| Herbicide | Soil | Documentation Issues | Record added by the validator | No | 3 | 349 | 0.86 | N/A |
| Herbicide | Soil | Holding Times | Holding times were exceeded | No | 13 | 349 | 3.72 | Representativeness |
| Herbicide | Soil | Internal Standards | Internal standards did not meet criteria | No | 2 | 349 | 0.57 | Accuracy |
| Herbicide | Soil | Other | Sample results were not validated due to re-analysis | No | 3 | 349 | 0.86 | N/A |
| Herbicide | Soil | Other | See hard copy for further explanation | No | 1 | 349 | 0.29 | N/A |
| Herbicide | Soil | Sample Preparation | Samples were not properly preserved in the field | No | 15 | 349 | 4.30 | Representativeness |
| Herbicide | Soil | Surrogates | Surrogate recovery criteria were not met | No | 2 | 349 | 0.57 | Accuracy |
| Herbicide | Water | Documentation Issues | Transcription error | No | 15 | 95 | 15.79 | N/A |
| Herbicide | Water | Surrogates | Surrogate recovery criteria were not met | No | 1 | 95 | 1.05 | Accuracy |
| Metal | Soil | Blanks | Calibration verification blank contamination | No | 542 | 12,381 | 4.38 | Representativeness |
| Metal | Soil | Blanks | Calibration verification blank contamination | Yes | 204 | 12,381 | 1.65 | Representativeness |
| Metal | Soil | Blanks | Method, preparation, or reagent blank contamination | No | 117 | 12,381 | 0.94 | Representativeness |
| Metal | Soil | Blanks | Method, preparation, or reagent blank contamination | Yes | 28 | 12,381 | 0.23 | Representativeness |
| Metal | Soil | Blanks | Negative bias indicated in the blanks | No | 34 | 12,381 | 0.27 | Representativeness |
| Metal | Soil | Blanks | Negative bias indicated in the blanks | Yes | 60 | 12,381 | 0.48 | Representativeness |
| Metal | Soil | Calculation Errors | Control limits not assigned correctly | No | 126 | 12,381 | 1.02 | N/A |
| Metal | Soil | Calculation Errors | Control limits not assigned correctly | Yes | 381 | 12,381 | 3.08 | N/A |
| Metal | Soil | Calibration | Calibration correlation coefficient did not meet requirements | No | 2 | 12,381 | 0.02 | Accuracy |
| Metal | Soil | Calibration | Calibration correlation coefficient did not meet requirements | Yes | 8 | 12,381 | 0.06 | Accuracy |
| Metal | Soil | Calibration | Continuing calibration verification criteria were not met | No | 12 | 12,381 | 0.10 | Accuracy |
| Metal | Soil | Calibration | Continuing calibration verification criteria were not met | Yes | 1 | 12,381 | 0.01 | Accuracy |
| Metal | Soil | Documentation Issues | Key data fields incorrect | No | 103 | 12,381 | 0.83 | N/A |
| Metal | Soil | Documentation Issues | Key data fields incorrect | Yes | 217 | 12,381 | 1.75 | N/A |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Metal | Soil | Documentation Issues | Missing deliverables (not required for validation) | No | 3 | 12,381 | 0.02 | N/A |
| Metal | Soil | Documentation Issues | Missing deliverables (not required for validation) | Yes | 20 | 12,381 | 0.16 | N/A |
| Metal | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 75 | 12,381 | 0.61 | N/A |
| Metal | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 229 | 12,381 | 1.85 | N/A |
| Metal | Soil | Documentation Issues | Record added by the validator | No | 18 | 12,381 | 0.15 | N/A |
| Metal | Soil | Documentation Issues | Record added by the validator | Yes | 74 | 12,381 | 0.60 | N/A |
| Metal | Soil | Documentation Issues | Transcription error | No | 94 | 12,381 | 0.76 | N/A |
| Metal | Soil | Documentation Issues | Transcription error | Yes | 181 | 12,381 | 1.46 | N/A |
| Metal | Soil | Holding Times | Holding times were exceeded | No | 18 | 12,381 | 0.15 | Representativeness |
| Metal | Soil | Holding Times | Holding times were grossly exceeded | Yes | 1 | 12,381 | 0.01 | Representativeness |
| Metal | Soil | Instrument Set-up | Interference was indicated in the interference check sample | No | 51 | 12,381 | 0.41 | Accuracy |
| Metal | Soil | Instrument Set-up | Interference was indicated in the interference check sample | Yes | 84 | 12,381 | 0.68 | Accuracy |
| Metal | Soil | LCS | CRDL check sample recovery criteria were not met | No | 96 | 12,381 | 0.78 | Accuracy |
| Metal | Soil | LCS | CRDL check sample recovery criteria were not met | Yes | 146 | 12,381 | 1.18 | Accuracy |
| Metal | Soil | LCS | LCS recovery criteria were not met | No | 309 | 12,381 | 2.50 | Accuracy |
| Metal | Soil | LCS | LCS recovery criteria were not met | Yes | 744 | 12,381 | 6.01 | Accuracy |
| Metal | Soil | LCS | Low level check sample recovery criteria were not met | No | 437 | 12,381 | 3.53 | Accuracy |
| Metal | Soil | LCS | Low level check sample recovery criteria were not met | Yes | 456 | 12,381 | 3.68 | Accuracy |
| Metal | Soil | Matrices | Duplicate sample precision criteria were not met | No | 26 | 12,381 | 0.21 | Precision |
| Metal | Soil | Matrices | Duplicate sample precision criteria were not met | Yes | 296 | 12,381 | 2.39 | Precision |
| Metal | Soil | Matrices | LCS/LCSD precision criteria were not met | No | 2 | 12,381 | 0.02 | Precision |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Metal | Soil | Matrices | LCS/LCSD precision criteria were not met | Yes | 114 | 12,381 | 0.92 | Precision |
| Metal | Soil | Matrices | MSA calibration correlation coefficient < 0.995 | Yes | 2 | 12,381 | 0.02 | Accuracy |
| Metal | Soil | Matrices | Post-digestion MS did not meet control criteria | No | 79 | 12,381 | 0.64 | Accuracy |
| Metal | Soil | Matrices | Post-digestion MS did not meet control criteria | Yes | 60 | 12,381 | 0.48 | Accuracy |
| Metal | Soil | Matrices | Predigestion MS recovery criteria were not met | No | 401 | 12,381 | 3.24 | Accuracy |
| Metal | Soil | Matrices | Predigestion MS recovery criteria were not met | Yes | 1,091 | 12,381 | 8.81 | Accuracy |
| Metal | Soil | Matrices | Predigestion MS recovery was < 30 percent | Yes | 30 | 12,381 | 0.24 | Accuracy |
| Metal | Soil | Matrices | Serial dilution criteria were not met | No | 1 | 12,381 | 0.01 | Accuracy |
| Metal | Soil | Matrices | Serial dilution criteria were not met | Yes | 270 | 12,381 | 2.18 | Accuracy |
| Metal | Soil | Other | IDL is older than 3 months from date of analysis | No | 484 | 12,381 | 3.91 | Accuracy |
| Metal | Soil | Other | IDL is older than 3 months from date of analysis | Yes | 1,591 | 12,381 | 12.85 | Accuracy |
| Metal | Soil | Other | Result obtained through dilution | Yes | 7 | 12,381 | 0.06 | N/A |
| Metal | Soil | Other | See hard copy for further explanation | No | 143 | 12,381 | 1.15 | N/A |
| Metal | Soil | Other | See hard copy for further explanation | Yes | 501 | 12,381 | 4.05 | N/A |
| Metal | Soil | Sensitivity | IDL changed due to a significant figure discrepancy | No | 3 | 12,381 | 0.02 | Representativeness |
| Metal | Water | Blanks | Calibration verification blank contamination | No | 1,007 | 38,884 | 2.59 | Representativeness |
| Metal | Water | Blanks | Calibration verification blank contamination | Yes | 158 | 38,884 | 0.41 | Representativeness |
| Metal | Water | Blanks | Method, preparation, or reagent blank contamination | No | 2,980 | 38,884 | 7.66 | Representativeness |
| Metal | Water | Blanks | Method, preparation, or reagent blank contamination | Yes | 177 | 38,884 | 0.46 | Representativeness |
| Metal | Water | Blanks | Negative bias indicated in the blanks | No | 479 | 38,884 | 1.23 | Representativeness |
| Metal | Water | Blanks | Negative bias indicated in the blanks | Yes | 319 | 38,884 | 0.82 | Representativeness |
| Metal | Water | Calculation Errors | Control limits not assigned correctly | No | 45 | 38,884 | 0.12 | N/A |
| Metal | Water | Calculation Errors | Control limits not assigned correctly | Yes | 39 | 38,884 | 0.10 | N/A |
| Metal | Water | Calibration | Calibration correlation coefficient did not meet requirements | No | 114 | 38,884 | 0.29 | Accuracy |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Metal | Water | Calibration | Calibration correlation coefficient did not meet requirements | Yes | 45 | 38,884 | 0.12 | Accuracy |
| Metal | Water | Calibration | Continuing calibration verification criteria were not met | No | 21 | 38,884 | 0.05 | Accuracy |
| Metal | Water | Calibration | Continuing calibration verification criteria were not met | Yes | 33 | 38,884 | 0.08 | Accuracy |
| Metal | Water | Documentation Issues | Electronic qualifiers were applied from validation report by hand | No | 18 | 38,884 | 0.05 | N/A |
| Metal | Water | Documentation Issues | Electronic qualifiers were applied from validation report by hand | Yes | 11 | 38,884 | 0.03 | N/A |
| Metal | Water | Documentation Issues | Information missing from case narrative | No | 24 | 38,884 | 0.06 | N/A |
| Metal | Water | Documentation Issues | Information missing from case narrative | Yes | 23 | 38,884 | 0.06 | N/A |
| Metal | Water | Documentation Issues | Key data fields incorrect | No | 70 | 38,884 | 0.18 | N/A |
| Metal | Water | Documentation Issues | Key data fields incorrect | Yes | 10 | 38,884 | 0.03 | N/A |
| Metal | Water | Documentation Issues | Missing deliverables (not required for validation) | No | 321 | 38,884 | 0.83 | N/A |
| Metal | Water | Documentation Issues | Missing deliverables (not required for validation) | Yes | 184 | 38,884 | 0.47 | N/A |
| Metal | Water | Documentation Issues | Missing deliverables (required for validation) | No | 130 | 38,884 | 0.33 | Representativeness |
| Metal | Water | Documentation Issues | Missing deliverables (required for validation) | Yes | 132 | 38,884 | 0.34 | Representativeness |
| Metal | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 742 | 38,884 | 1.91 | N/A |
| Metal | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 973 | 38,884 | 2.50 | N/A |
| Metal | Water | Documentation Issues | Omissions or errors in data package (required for validation) | No | 13 | 38,884 | 0.03 | Representativeness |
| Metal | Water | Documentation Issues | Omissions or errors in data package (required for validation) | Yes | 3 | 38,884 | 0.01 | Representativeness |
| Metal | Water | Documentation Issues | Record added by the validator | No | 34 | 38,884 | 0.09 | N/A |
| Metal | Water | Documentation Issues | Record added by the validator | Yes | 20 | 38,884 | 0.05 | N/A |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Metal | Water | Documentation Issues | Transcription error | No | 1,657 | 38,884 | 4.26 | N/A |
| Metal | Water | Documentation Issues | Transcription error | Yes | 563 | 38,884 | 1.45 | N/A |
| Metal | Water | Holding Times | Holding times were exceeded | No | 25 | 38,884 | 0.06 | Representativeness |
| Metal | Water | Holding Times | Holding times were exceeded | Yes | 4 | 38,884 | 0.01 | Representativeness |
| Metal | Water | Instrument Set-up | AA duplicate injection precision criteria were not met | No | 4 | 38,884 | 0.01 | Precision |
| Metal | Water | Instrument Set-up | Interference was indicated in the interference check sample | No | 91 | 38,884 | 0.23 | Accuracy |
| Metal | Water | Instrument Set-up | Interference was indicated in the interference check sample | Yes | 145 | 38,884 | 0.37 | Accuracy |
| Metal | Water | LCS | CRDL check sample recovery criteria were not met | No | 164 | 38,884 | 0.42 | Accuracy |
| Metal | Water | LCS | CRDL check sample recovery criteria were not met | Yes | 137 | 38,884 | 0.35 | Accuracy |
| Metal | Water | LCS | LCS data not submitted by the laboratory | No | 1 | 38,884 | 0.00 | Representativeness |
| Metal | Water | LCS | LCS recovery criteria were not met | No | 50 | 38,884 | 0.13 | Accuracy |
| Metal | Water | LCS | LCS recovery criteria were not met | Yes | 42 | 38,884 | 0.11 | Accuracy |
| Metal | Water | LCS | Low level check sample recovery criteria were not met | No | 213 | 38,884 | 0.55 | Accuracy |
| Metal | Water | LCS | Low level check sample recovery criteria were not met | Yes | 189 | 38,884 | 0.49 | Accuracy |
| Metal | Water | LCS | QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed | No | 85 | 38,884 | 0.22 | Representativeness |
| Metal | Water | LCS | QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed | Yes | 63 | 38,884 | 0.16 | Representativeness |
| Metal | Water | Matrices | Duplicate sample precision criteria were not met | No | 34 | 38,884 | 0.09 | Precision |
| Metal | Water | Matrices | Duplicate sample precision criteria were not met | Yes | 243 | 38,884 | 0.62 | Precision |
| Metal | Water | Matrices | LCS/LCSD precision criteria were not met | No | 54 | 38,884 | 0.14 | Precision |
| Metal | Water | Matrices | LCS/LCSD precision criteria were not met | Yes | 56 | 38,884 | 0.14 | Precision |
| Metal | Water | Matrices | MSA calibration correlation coefficient < 0.995 | No | 1 | 38,884 | 0.00 | Accuracy |
| Metal | Water | Matrices | MSA calibration correlation coefficient < 0.995 | Yes | 6 | 38,884 | 0.02 | Accuracy |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Metal | Water | Matrices | Post-digestion MS did not meet control criteria | No | 342 | 38,884 | 0.88 | Accuracy |
| Metal | Water | Matrices | Post-digestion MS did not meet control criteria | Yes | 88 | 38,884 | 0.23 | Accuracy |
| Metal | Water | Matrices | Predigestion MS recovery criteria were not met | No | 378 | 38,884 | 0.97 | Accuracy |
| Metal | Water | Matrices | Predigestion MS recovery criteria were not met | Yes | 534 | 38,884 | 1.37 | Accuracy |
| Metal | Water | Matrices | Predigestion MS recovery was < 30 percent | Yes | 11 | 38,884 | 0.03 | Accuracy |
| Metal | Water | Matrices | Recovery criteria were not met | Yes | 7 | 38,884 | 0.02 | Accuracy |
| Metal | Water | Matrices | Serial dilution criteria were not met | No | 24 | 38,884 | 0.06 | Accuracy |
| Metal | Water | Matrices | Serial dilution criteria were not met | Yes | 615 | 38,884 | 1.58 | Accuracy |
| Metal | Water | Matrices | Site samples were not used for sample matrix QC | No | 1 | 38,884 | 0.00 | Representativeness |
| Metal | Water | Other | Analysis was not requested according to the statement of work | No | 1 | 38,884 | 0.00 | N/A |
| Metal | Water | Other | IDL is older than 3 months from date of analysis | No | 385 | 38,884 | 0.99 | Accuracy |
| Metal | Water | Other | IDL is older than 3 months from date of analysis | Yes | 398 | 38,884 | 1.02 | Accuracy |
| Metal | Water | Other | Incorrect analysis sequence | No | 5 | 38,884 | 0.01 | Representativeness |
| Metal | Water | Other | Incorrect analysis sequence | Yes | 7 | 38,884 | 0.02 | Representativeness |
| Metal | Water | Other | QC sample frequency does not meet method requirements | No | 1 | 38,884 | 0.00 | Representativeness |
| Metal | Water | Other | Result obtained through dilution | No | 2 | 38,884 | 0.01 | N/A |
| Metal | Water | Other | Result obtained through dilution | Yes | 22 | 38,884 | 0.06 | N/A |
| Metal | Water | Other | See hard copy for further explanation | No | 41 | 38,884 | 0.11 | N/A |
| Metal | Water | Other | See hard copy for further explanation | Yes | 46 | 38,884 | 0.12 | N/A |
| Metal | Water | Sample Preparation | Samples were not properly preserved in the field | No | 266 | 38,884 | 0.68 | Representativeness |
| Metal | Water | Sample Preparation | Samples were not properly preserved in the field | Yes | 396 | 38,884 | 1.02 | Representativeness |
| Metal | Water | Sensitivity | IDL changed due to a significant figure discrepancy | No | 124 | 38,884 | 0.32 | Representativeness |
| PCB | Soil | Calibration | Continuing calibration verification criteria were not met | No | 112 | 1,882 | 5.95 | Accuracy |
| PCB | Soil | Confirmation | Confirmation percent difference criteria not met | No | 1 | 1,882 | 0.05 | Precision |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| PCB | Soil | Confirmation | Confirmation percent difference criteria not met | Yes | 5 | 1,882 | 0.27 | Precision |
| PCB | Soil | Documentation Issues | Missing deliverables (not required for validation) | No | 14 | 1,882 | 0.74 | N/A |
| PCB | Soil | Documentation Issues | Transcription error | No | 21 | 1,882 | 1.12 | N/A |
| PCB | Soil | Documentation Issues | Transcription error | Yes | 2 | 1,882 | 0.11 | N/A |
| PCB | Soil | Holding Times | Holding times were exceeded | No | 75 | 1,882 | 3.99 | Representativeness |
| PCB | Soil | Holding Times | Holding times were exceeded | Yes | 2 | 1,882 | 0.11 | Representativeness |
| PCB | Soil | Other | See hard copy for further explanation | Yes | 1 | 1,882 | 0.05 | N/A |
| PCB | Soil | Sample Preparation | Samples were not properly preserved in the field | No | 134 | 1,882 | 7.12 | Representativeness |
| PCB | Soil | Sample Preparation | Samples were not properly preserved in the field | Yes | 6 | 1,882 | 0.32 | Representativeness |
| PCB | Soil | Surrogates | Surrogate recovery criteria were not met | No | 130 | 1,882 | 6.91 | Accuracy |
| PCB | Soil | Surrogates | Surrogate recovery criteria were not met | Yes | 10 | 1,882 | 0.53 | Accuracy |
| PCB | Water | Documentation Issues | Key data fields incorrect | No | 7 | 455 | 1.54 | N/A |
| PCB | Water | Documentation Issues | Transcription error | No | 21 | 455 | 4.62 | N/A |
| Pesticide | Soil | Calculation Errors | Calculation error | No | 8 | 2,688 | 0.30 | N/A |
| Pesticide | Soil | Calibration | Continuing calibration verification criteria were not met | No | 18 | 2,688 | 0.67 | Accuracy |
| Pesticide | Soil | Calibration | Independent calibration verification criteria not met | No | 12 | 2,688 | 0.45 | Accuracy |
| Pesticide | Soil | Confirmation | Confirmation percent difference criteria not met | Yes | 3 | 2,688 | 0.11 | Precision |
| Pesticide | Soil | Documentation Issues | Record added by the validator | No | 3 | 2,688 | 0.11 | N/A |
| Pesticide | Soil | Documentation Issues | Transcription error | No | 43 | 2,688 | 1.60 | N/A |
| Pesticide | Soil | Holding Times | Holding times were exceeded | No | 225 | 2,688 | 8.37 | Representativeness |
| Pesticide | Soil | Internal Standards | Internal standards did not meet criteria | No | 2 | 2,688 | 0.07 | Accuracy |
| Pesticide | Soil | Other | Sample results were not validated due to re-analysis | No | 3 | 2,688 | 0.11 | N/A |
| Pesticide | Soil | Other | See hard copy for further explanation | No | 4 | 2,688 | 0.15 | N/A |
| Pesticide | Soil | Sample Preparation | Samples were not properly preserved in the field | No | 15 | 2,688 | 0.56 | Representativeness |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Pesticide | Soil | Surrogates | Surrogate recovery criteria were not met | No | 139 | 2,688 | 5.17 | Accuracy |
| Pesticide | Soil | Surrogates | Surrogate recovery criteria were not met | Yes | 11 | 2,688 | 0.41 | Accuracy |
| Pesticide | Water | Calibration | Continuing calibration verification criteria were not met | No | 7 | 1,377 | 0.51 | Accuracy |
| Pesticide | Water | Documentation Issues | Key data fields incorrect | No | 20 | 1,377 | 1.45 | N/A |
| Pesticide | Water | Documentation Issues | Transcription error | No | 1 | 1,377 | 0.07 | N/A |
| Radionuclide | Soil | Blanks | Blank recovery criteria were not met | Yes | 54 | 3,541 | 1.52 | Representativeness |
| Radionuclide | Soil | Blanks | Method, preparation, or reagent blank contamination | No | 6 | 3,541 | 0.17 | Representativeness |
| Radionuclide | Soil | Blanks | Method, preparation, or reagent blank contamination | Yes | 119 | 3,541 | 3.36 | Representativeness |
| Radionuclide | Soil | Calculation Errors | Calculation error | No | 2 | 3,541 | 0.06 | N/A |
| Radionuclide | Soil | Calculation Errors | Calculation error | Yes | 15 | 3,541 | 0.42 | N/A |
| Radionuclide | Soil | Calibration | Continuing calibration verification criteria were not met | No | 3 | 3,541 | 0.08 | Accuracy |
| Radionuclide | Soil | Calibration | Continuing calibration verification criteria were not met | Yes | 222 | 3,541 | 6.27 | Accuracy |
| Radionuclide | Soil | Calibration | Frequency or sequencing verification criteria not met | Yes | 4 | 3,541 | 0.11 | Accuracy |
| Radionuclide | Soil | Documentation Issues | Information missing from case narrative | No | 3 | 3,541 | 0.08 | N/A |
| Radionuclide | Soil | Documentation Issues | Information missing from case narrative | Yes | 2 | 3,541 | 0.06 | N/A |
| Radionuclide | Soil | Documentation Issues | Key data fields incorrect | Yes | 52 | 3,541 | 1.47 | N/A |
| Radionuclide | Soil | Documentation Issues | Missing deliverables (required for validation) | No | 11 | 3,541 | 0.31 | Representativeness |
| Radionuclide | Soil | Documentation Issues | Missing deliverables (required for validation) | Yes | 30 | 3,541 | 0.85 | Representativeness |
| Radionuclide | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 70 | 3,541 | 1.98 | N/A |
| Radionuclide | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 229 | 3,541 | 6.47 | N/A |
| Radionuclide | Soil | Documentation Issues | Omissions or errors in data package (required for validation) | No | 53 | 3,541 | 1.50 | Representativeness |
| Radionuclide | Soil | Documentation Issues | Omissions or errors in data package (required for validation) | Yes | 122 | 3,541 | 3.45 | Representativeness |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Radionuclide | Soil | Documentation Issues | Record added by the validator | Yes | 48 | 3,541 | 1.36 | N/A |
| Radionuclide | Soil | Documentation Issues | Results were not included on Data Summary Table | No | 11 | 3,541 | 0.31 | N/A |
| Radionuclide | Soil | Documentation Issues | Results were not included on Data Summary Table | Yes | 11 | 3,541 | 0.31 | N/A |
| Radionuclide | Soil | Documentation Issues | Sufficient documentation not provided by the laboratory | Yes | 254 | 3,541 | 7.17 | Representativeness |
| Radionuclide | Soil | Documentation Issues | Transcription error | No | 17 | 3,541 | 0.48 | N/A |
| Radionuclide | Soil | Documentation Issues | Transcription error | Yes | 140 | 3,541 | 3.95 | N/A |
| Radionuclide | Soil | Holding Times | Holding times were grossly exceeded | Yes | 3 | 3,541 | 0.08 | Representativeness |
| Radionuclide | Soil | Instrument Set-up | Detector efficiency did not meet requirements | Yes | 19 | 3,541 | 0.54 | Accuracy |
| Radionuclide | Soil | Instrument Set-up | Instrument gain and/or efficiency not submitted | No | 11 | 3,541 | 0.31 | Representativeness |
| Radionuclide | Soil | Instrument Set-up | Resolution criteria were not met | No | 3 | 3,541 | 0.08 | Representativeness |
| Radionuclide | Soil | Instrument Set-up | Resolution criteria were not met | Yes | 8 | 3,541 | 0.23 | Representativeness |
| Radionuclide | Soil | LCS | Lab control samples >+/- 2 sigma and <+/- 3 sigma | No | 2 | 3,541 | 0.06 | Accuracy |
| Radionuclide | Soil | LCS | Lab control samples >+/- 2 sigma and <+/- 3 sigma | Yes | 15 | 3,541 | 0.42 | Accuracy |
| Radionuclide | Soil | LCS | LCS data not submitted by the laboratory | Yes | 23 | 3,541 | 0.65 | Representativeness |
| Radionuclide | Soil | LCS | LCS recovery > +/- 3 sigma | Yes | 149 | 3,541 | 4.21 | Accuracy |
| Radionuclide | Soil | LCS | LCS recovery criteria were not met | No | 1 | 3,541 | 0.03 | Accuracy |
| Radionuclide | Soil | LCS | LCS recovery criteria were not met | Yes | 30 | 3,541 | 0.85 | Accuracy |
| Radionuclide | Soil | LCS | LCS relative percent error criteria not met | No | 1 | 3,541 | 0.03 | Accuracy |
| Radionuclide | Soil | LCS | LCS relative percent error criteria not met | Yes | 126 | 3,541 | 3.56 | Accuracy |
| Radionuclide | Soil | Matrices | Duplicate sample precision criteria were not met | Yes | 1 | 3,541 | 0.03 | Precision |
| Radionuclide | Soil | Matrices | Recovery criteria were not met | Yes | 38 | 3,541 | 1.07 | Accuracy |
| Radionuclide | Soil | Matrices | Replicate analysis was not performed | No | 6 | 3,541 | 0.17 | Precision |
| Radionuclide | Soil | Matrices | Replicate analysis was not performed | Yes | 4 | 3,541 | 0.11 | Precision |
| Radionuclide | Soil | Matrices | Replicate precision criteria were not met | No | 2 | 3,541 | 0.06 | Precision |
| Radionuclide | Soil | Matrices | Replicate precision criteria were not met | Yes | 198 | 3,541 | 5.59 | Precision |
| Radionuclide | Soil | Matrices | Replicate recovery criteria were not met | No | 2 | 3,541 | 0.06 | Accuracy |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Radionuclide | Soil | Matrices | Replicate recovery criteria were not met | Yes | 36 | 3,541 | 1.02 | Accuracy |
| Radionuclide | Soil | Other | Lab results not verified due to unsubmitted data | Yes | 134 | 3,541 | 3.78 | Representativeness |
| Radionuclide | Soil | Other | QC sample does not meet method requirements | No | 17 | 3,541 | 0.48 | Representativeness |
| Radionuclide | Soil | Other | QC sample does not meet method requirements | Yes | 55 | 3,541 | 1.55 | Representativeness |
| Radionuclide | Soil | Other | Sample exceeded efficiency curve weight limit | Yes | 3 | 3,541 | 0.08 | Accuracy |
| Radionuclide | Soil | Other | See hard copy for further explanation | No | 26 | 3,541 | 0.73 | N/A |
| Radionuclide | Soil | Other | See hard copy for further explanation | Yes | 201 | 3,541 | 5.68 | N/A |
| Radionuclide | Soil | Other | Tracer requirements were not met | No | 22 | 3,541 | 0.62 | Accuracy |
| Radionuclide | Soil | Other | Tracer requirements were not met | Yes | 70 | 3,541 | 1.98 | Accuracy |
| Radionuclide | Soil | Sample Preparation | Samples were not properly preserved in the field | No | 3 | 3,541 | 0.08 | Representativeness |
| Radionuclide | Soil | Sample Preparation | Samples were not properly preserved in the field | Yes | 2 | 3,541 | 0.06 | Representativeness |
| Radionuclide | Soil | Sensitivity | Incorrect reported activity or MDA | No | 10 | 3,541 | 0.28 | N/A |
| Radionuclide | Soil | Sensitivity | Incorrect reported activity or MDA | Yes | 1 | 3,541 | 0.03 | N/A |
| Radionuclide | Soil | Sensitivity | MDA exceeded the RDL | No | 2 | 3,541 | 0.06 | Representativeness |
| Radionuclide | Soil | Sensitivity | MDA exceeded the RDL | Yes | 67 | 3,541 | 1.89 | Representativeness |
| Radionuclide | Soil | Sensitivity | MDA was calculated by reviewer | Yes | 796 | 3,541 | 22.48 | N/A |
| Radionuclide | Soil | Sensitivity | Results considered qualitative not quantitative | No | 12 | 3,541 | 0.34 | Accuracy |
| Radionuclide | Soil | Sensitivity | Results considered qualitative not quantitative | Yes | 22 | 3,541 | 0.62 | Accuracy |
| Radionuclide | Water | Blanks | Blank recovery criteria were not met | No | 9 | 9,345 | 0.10 | Representativeness |
| Radionuclide | Water | Blanks | Blank recovery criteria were not met | Yes | 78 | 9,345 | 0.83 | Representativeness |
| Radionuclide | Water | Blanks | Method, preparation, or reagent blank contamination | No | 100 | 9,345 | 1.07 | Representativeness |
| Radionuclide | Water | Blanks | Method, preparation, or reagent blank contamination | Yes | 625 | 9,345 | 6.69 | Representativeness |
| Radionuclide | Water | Calculation Errors | Calculation error | No | 17 | 9,345 | 0.18 | N/A |
| Radionuclide | Water | Calculation Errors | Calculation error | Yes | 35 | 9,345 | 0.37 | N/A |
| Radionuclide | Water | Calibration | Calibration counting statistics did not meet criteria | No | 39 | 9,345 | 0.42 | Accuracy |
| Radionuclide | Water | Calibration | Calibration counting statistics did not meet criteria | Yes | 1 | 9,345 | 0.01 | Accuracy |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Radionuclide | Water | Calibration | Continuing calibration verification criteria were not met | No | 109 | 9,345 | 1.17 | Accuracy |
| Radionuclide | Water | Calibration | Continuing calibration verification criteria were not met | Yes | 878 | 9,345 | 9.40 | Accuracy |
| Radionuclide | Water | Documentation Issues | Information missing from case narrative | No | 2 | 9,345 | 0.02 | N/A |
| Radionuclide | Water | Documentation Issues | Information missing from case narrative | Yes | 8 | 9,345 | 0.09 | N/A |
| Radionuclide | Water | Documentation Issues | Missing deliverables (required for validation) | No | 17 | 9,345 | 0.18 | Representativeness |
| Radionuclide | Water | Documentation Issues | Missing deliverables (required for validation) | Yes | 21 | 9,345 | 0.22 | Representativeness |
| Radionuclide | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 50 | 9,345 | 0.54 | N/A |
| Radionuclide | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 97 | 9,345 | 1.04 | N/A |
| Radionuclide | Water | Documentation Issues | Omissions or errors in data package (required for validation) | No | 3 | 9,345 | 0.03 | Representativeness |
| Radionuclide | Water | Documentation Issues | Omissions or errors in data package (required for validation) | Yes | 5 | 9,345 | 0.05 | Representativeness |
| Radionuclide | Water | Documentation Issues | Record added by the validator | Yes | 43 | 9,345 | 0.46 | N/A |
| Radionuclide | Water | Documentation Issues | Sufficient documentation not provided by the laboratory | No | 7 | 9,345 | 0.07 | Representativeness |
| Radionuclide | Water | Documentation Issues | Sufficient documentation not provided by the laboratory | Yes | 806 | 9,345 | 8.62 | Representativeness |
| Radionuclide | Water | Documentation Issues | Transcription error | No | 360 | 9,345 | 3.85 | N/A |
| Radionuclide | Water | Documentation Issues | Transcription error | Yes | 362 | 9,345 | 3.87 | N/A |
| Radionuclide | Water | Holding Times | Holding times were exceeded | No | 6 | 9,345 | 0.06 | Representativeness |
| Radionuclide | Water | Holding Times | Holding times were exceeded | Yes | 12 | 9,345 | 0.13 | Representativeness |
| Radionuclide | Water | Holding Times | Holding times were grossly exceeded | Yes | 1 | 9,345 | 0.01 | Representativeness |
| Radionuclide | Water | Instrument Set-up | Resolution criteria were not met | No | 9 | 9,345 | 0.10 | Representativeness |
| Radionuclide | Water | Instrument Set-up | Resolution criteria were not met | Yes | 79 | 9,345 | 0.85 | Representativeness |
| Radionuclide | Water | Instrument Set-up | Transformed spectral index external site criteria were not met | No | 9 | 9,345 | 0.10 | Representativeness |
| Radionuclide | Water | Instrument Set-up | Transformed spectral index external site criteria were not met | Yes | 2 | 9,345 | 0.02 | Representativeness |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Radionuclide | Water | LCS | Expected LCS value not submitted/verifiable | No | 19 | 9,345 | 0.20 | Representativeness |
| Radionuclide | Water | LCS | Expected LCS value not submitted/verifiable | Yes | 93 | 9,345 | 1.00 | Representativeness |
| Radionuclide | Water | LCS | LCS data not submitted by the laboratory | Yes | 3 | 9,345 | 0.03 | Representativeness |
| Radionuclide | Water | LCS | LCS recovery > +/- 3 sigma | No | 120 | 9,345 | 1.28 | Accuracy |
| Radionuclide | Water | LCS | LCS recovery > +/- 3 sigma | Yes | 306 | 9,345 | 3.27 | Accuracy |
| Radionuclide | Water | LCS | LCS recovery criteria were not met | No | 12 | 9,345 | 0.13 | Accuracy |
| Radionuclide | Water | LCS | LCS recovery criteria were not met | Yes | 50 | 9,345 | 0.54 | Accuracy |
| Radionuclide | Water | LCS | LCS relative percent error criteria not met | No | 23 | 9,345 | 0.25 | Accuracy |
| Radionuclide | Water | LCS | LCS relative percent error criteria not met | Yes | 303 | 9,345 | 3.24 | Accuracy |
| Radionuclide | Water | Matrices | Duplicate sample precision criteria were not met | Yes | 6 | 9,345 | 0.06 | Precision |
| Radionuclide | Water | Matrices | Recovery criteria were not met | No | 16 | 9,345 | 0.17 | Accuracy |
| Radionuclide | Water | Matrices | Recovery criteria were not met | Yes | 91 | 9,345 | 0.97 | Accuracy |
| Radionuclide | Water | Matrices | Replicate analysis was not performed | No | 43 | 9,345 | 0.46 | Precision |
| Radionuclide | Water | Matrices | Replicate analysis was not performed | Yes | 193 | 9,345 | 2.07 | Precision |
| Radionuclide | Water | Matrices | Replicate precision criteria were not met | No | 54 | 9,345 | 0.58 | Precision |
| Radionuclide | Water | Matrices | Replicate precision criteria were not met | Yes | 448 | 9,345 | 4.79 | Precision |
| Radionuclide | Water | Matrices | Replicate recovery criteria were not met | No | 8 | 9,345 | 0.09 | Accuracy |
| Radionuclide | Water | Matrices | Replicate recovery criteria were not met | Yes | 51 | 9,345 | 0.55 | Accuracy |
| Radionuclide | Water | Other | Lab results not verified due to unsubmitted data | No | 1 | 9,345 | 0.01 | Representativeness |
| Radionuclide | Water | Other | Lab results not verified due to unsubmitted data | Yes | 2 | 9,345 | 0.02 | Representativeness |
| Radionuclide | Water | Other | QC sample does not meet method requirements | No | 43 | 9,345 | 0.46 | Representativeness |
| Radionuclide | Water | Other | QC sample does not meet method requirements | Yes | 61 | 9,345 | 0.65 | Representativeness |
| Radionuclide | Water | Other | Sample exceeded efficiency curve weight limit | Yes | 5 | 9,345 | 0.05 | Accuracy |
| Radionuclide | Water | Other | Sample results not submitted/verifiable | Yes | 1 | 9,345 | 0.01 | Representativeness |
| Radionuclide | Water | Other | Sample results were not validated due to re-analysis | No | 1 | 9,345 | 0.01 | N/A |
| Radionuclide | Water | Other | Sample results were not validated due to re-analysis | Yes | 4 | 9,345 | 0.04 | N/A |
| Radionuclide | Water | Other | See hard copy for further explanation | No | 30 | 9,345 | 0.32 | N/A |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Radionuclide | Water | Other | See hard copy for further explanation | Yes | 344 | 9,345 | 3.68 | N/A |
| Radionuclide | Water | Other | Tracer requirements were not met | No | 47 | 9,345 | 0.50 | Accuracy |
| Radionuclide | Water | Other | Tracer requirements were not met | Yes | 88 | 9,345 | 0.94 | Accuracy |
| Radionuclide | Water | Sample Preparation | Improper aliquot size | No | 1 | 9,345 | 0.01 | Accuracy |
| Radionuclide | Water | Sample Preparation | Improper aliquot size | Yes | 27 | 9,345 | 0.29 | Accuracy |
| Radionuclide | Water | Sample Preparation | Samples were not properly preserved in the field | No | 7 | 9,345 | 0.07 | Representativeness |
| Radionuclide | Water | Sample Preparation | Samples were not properly preserved in the field | Yes | 9 | 9,345 | 0.10 | Representativeness |
| Radionuclide | Water | Sensitivity | Incorrect reported activity or MDA | No | 6 | 9,345 | 0.06 | N/A |
| Radionuclide | Water | Sensitivity | Incorrect reported activity or MDA | Yes | 47 | 9,345 | 0.50 | N/A |
| Radionuclide | Water | Sensitivity | MDA exceeded the RDL | No | 31 | 9,345 | 0.33 | Representativeness |
| Radionuclide | Water | Sensitivity | MDA exceeded the RDL | Yes | 284 | 9,345 | 3.04 | Representativeness |
| Radionuclide | Water | Sensitivity | MDA was calculated by reviewer | No | 36 | 9,345 | 0.39 | N/A |
| Radionuclide | Water | Sensitivity | MDA was calculated by reviewer | Yes | 1,790 | 9,345 | 19.15 | N/A |
| SVOC | Soil | Blanks | Method, preparation, or reagent blank contamination | No | 13 | 18,490 | 0.07 | Representativeness |
| SVOC | Soil | Blanks | Method, preparation, or reagent blank contamination | Yes | 13 | 18,490 | 0.07 | Representativeness |
| SVOC | Soil | Calibration | Continuing calibration verification criteria were not met | No | 111 | 18,490 | 0.60 | Accuracy |
| SVOC | Soil | Calibration | Continuing calibration verification criteria were not met | Yes | 17 | 18,490 | 0.09 | Accuracy |
| SVOC | Soil | Calibration | Independent calibration verification criteria not met | No | 26 | 18,490 | 0.14 | Accuracy |
| SVOC | Soil | Documentation Issues | Missing deliverables (not required for validation) | No | 23 | 18,490 | 0.12 | N/A |
| SVOC | Soil | Documentation Issues | Missing deliverables (not required for validation) | Yes | 1 | 18,490 | 0.01 | N/A |
| SVOC | Soil | Documentation Issues | No mass spectra were provided | Yes | 1 | 18,490 | 0.01 | Representativeness |
| SVOC | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 90 | 18,490 | 0.49 | N/A |
| SVOC | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 6 | 18,490 | 0.03 | N/A |
| SVOC | Soil | Documentation Issues | Omissions or errors in data package (required for validation) | No | 3 | 18,490 | 0.02 | Representativeness |
| SVOC | Soil | Documentation Issues | Record added by the validator | No | 177 | 18,490 | 0.96 | N/A |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| SVOC | Soil | Documentation Issues | Transcription error | No | 3 | 18,490 | 0.02 | N/A |
| SVOC | Soil | Holding Times | Holding times were exceeded | No | 178 | 18,490 | 0.96 | Representativeness |
| SVOC | Soil | Holding Times | Holding times were exceeded | Yes | 19 | 18,490 | 0.10 | Representativeness |
| SVOC | Soil | Internal Standards | Internal standards did not meet criteria | No | 145 | 18,490 | 0.78 | Accuracy |
| SVOC | Soil | Internal Standards | Internal standards did not meet criteria | Yes | 42 | 18,490 | 0.23 | Accuracy |
| SVOC | Soil | Matrices | MS/MSD precision criteria were not met | No | 4 | 18,490 | 0.02 | Precision |
| SVOC | Soil | Other | Sample results were not validated due to re-analysis | No | 167 | 18,490 | 0.90 | N/A |
| SVOC | Soil | Other | Sample results were not validated due to re-analysis | Yes | 4 | 18,490 | 0.02 | N/A |
| SVOC | Soil | Other | See hard copy for further explanation | No | 58 | 18,490 | 0.31 | N/A |
| SVOC | Soil | Other | See hard copy for further explanation | Yes | 1 | 18,490 | 0.01 | N/A |
| SVOC | Soil | Sample Preparation | Samples were not properly preserved in the field | No | 861 | 18,490 | 4.66 | Representativeness |
| SVOC | Soil | Surrogates | Surrogate recovery criteria were not met | No | 102 | 18,490 | 0.55 | Accuracy |
| SVOC | Soil | Surrogates | Surrogate recovery criteria were not met | Yes | 18 | 18,490 | 0.10 | Accuracy |
| SVOC | Water | Blanks | Method, preparation, or reagent blank contamination | No | 11 | 7,226 | 0.15 | Representativeness |
| SVOC | Water | Blanks | Method, preparation, or reagent blank contamination | Yes | 5 | 7,226 | 0.07 | Representativeness |
| SVOC | Water | Calibration | Continuing calibration verification criteria were not met | No | 108 | 7,226 | 1.49 | Accuracy |
| SVOC | Water | Calibration | Continuing calibration verification criteria were not met | Yes | 9 | 7,226 | 0.12 | Accuracy |
| SVOC | Water | Calibration | Independent calibration verification criteria not met | No | 28 | 7,226 | 0.39 | Accuracy |
| SVOC | Water | Documentation Issues | Information missing from case narrative | No | 9 | 7,226 | 0.12 | N/A |
| SVOC | Water | Documentation Issues | Key data fields incorrect | No | 3 | 7,226 | 0.04 | N/A |
| SVOC | Water | Documentation Issues | Missing deliverables (not required for validation) | No | 81 | 7,226 | 1.12 | N/A |
| SVOC | Water | Documentation Issues | Missing deliverables (required for validation) | No | 12 | 7,226 | 0.17 | Representativeness |
| SVOC | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 308 | 7,226 | 4.26 | N/A |
| SVOC | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 4 | 7,226 | 0.06 | N/A |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| SVOC | Water | Documentation Issues | Omissions or errors in data package (required for validation) | No | 3 | 7,226 | 0.04 | Representativeness |
| SVOC | Water | Documentation Issues | Original documentation not provided | No | 3 | 7,226 | 0.04 | N/A |
| SVOC | Water | Documentation Issues | Transcription error | No | 622 | 7,226 | 8.61 | N/A |
| SVOC | Water | Documentation Issues | Transcription error | Yes | 5 | 7,226 | 0.07 | N/A |
| SVOC | Water | Holding Times | Holding times were exceeded | No | 303 | 7,226 | 4.19 | Representativeness |
| SVOC | Water | Holding Times | Holding times were exceeded | Yes | 3 | 7,226 | 0.04 | Representativeness |
| SVOC | Water | Instrument Set-up | Instrument tune criteria were not met | No | 186 | 7,226 | 2.57 | Accuracy |
| SVOC | Water | Instrument Set-up | Instrument tune criteria were not met | Yes | 1 | 7,226 | 0.01 | Accuracy |
| SVOC | Water | Internal Standards | Internal standards did not meet criteria | No | 16 | 7,226 | 0.22 | Accuracy |
| SVOC | Water | LCS | LCS recovery criteria were not met | No | 125 | 7,226 | 1.73 | Accuracy |
| SVOC | Water | LCS | LCS recovery criteria were not met | Yes | 2 | 7,226 | 0.03 | Accuracy |
| SVOC | Water | Matrices | MS/MSD precision criteria were not met | No | 5 | 7,226 | 0.07 | Precision |
| SVOC | Water | Other | Sample results were not validated due to re-analysis | No | 27 | 7,226 | 0.37 | N/A |
| SVOC | Water | Other | Sample results were not validated due to re-analysis | Yes | 2 | 7,226 | 0.03 | N/A |
| SVOC | Water | Other | See hard copy for further explanation | No | 31 | 7,226 | 0.43 | N/A |
| SVOC | Water | Other | See hard copy for further explanation | Yes | 4 | 7,226 | 0.06 | N/A |
| SVOC | Water | Sample Preparation | Preservation requirements were not met by the laboratory | No | 9 | 7,226 | 0.12 | Representativeness |
| SVOC | Water | Sample Preparation | Samples were not properly preserved in the field | No | 79 | 7,226 | 1.09 | Representativeness |
| SVOC | Water | Sample Preparation | Samples were not properly preserved in the field | Yes | 1 | 7,226 | 0.01 | Representativeness |
| SVOC | Water | Surrogates | Surrogate recovery criteria were not met | No | 55 | 7,226 | 0.76 | Accuracy |
| VOC | Soil | Blanks | Method, preparation, or reagent blank contamination | No | 166 | 25,407 | 0.65 | Representativeness |
| VOC | Soil | Blanks | Method, preparation, or reagent blank contamination | Yes | 162 | 25,407 | 0.64 | Representativeness |
| VOC | Soil | Calculation Errors | Calculation error | No | 32 | 25,407 | 0.13 | N/A |
| VOC | Soil | Calculation Errors | Calculation error | Yes | 2 | 25,407 | 0.01 | N/A |
| VOC | Soil | Calibration | Continuing calibration verification criteria were not met | No | 554 | 25,407 | 2.18 | Accuracy |
| VOC | Soil | Calibration | Continuing calibration verification criteria were not met | Yes | 42 | 25,407 | 0.17 | Accuracy |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| VOC | Soil | Calibration | Independent calibration verification criteria not met | No | 81 | 25,407 | 0.32 | Accuracy |
| VOC | Soil | Calibration | Independent calibration verification criteria not met | Yes | 4 | 25,407 | 0.02 | Accuracy |
| VOC | Soil | Calibration | Original result exceeded linear range, serial dilution value reported | Yes | 1 | 25,407 | 0.00 | Accuracy |
| VOC | Soil | Documentation Issues | Key data fields incorrect | No | 30 | 25,407 | 0.12 | N/A |
| VOC | Soil | Documentation Issues | Key data fields incorrect | Yes | 1 | 25,407 | 0.00 | N/A |
| VOC | Soil | Documentation Issues | Missing deliverables (not required for validation) | No | 479 | 25,407 | 1.89 | N/A |
| VOC | Soil | Documentation Issues | Missing deliverables (not required for validation) | Yes | 5 | 25,407 | 0.02 | N/A |
| VOC | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 1,918 | 25,407 | 7.55 | N/A |
| VOC | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 50 | 25,407 | 0.20 | N/A |
| VOC | Soil | Documentation Issues | Omissions or errors in data package (required for validation) | No | 61 | 25,407 | 0.24 | Representativeness |
| VOC | Soil | Documentation Issues | Record added by the validator | No | 12 | 25,407 | 0.05 | N/A |
| VOC | Soil | Documentation Issues | Transcription error | No | 228 | 25,407 | 0.90 | N/A |
| VOC | Soil | Documentation Issues | Transcription error | Yes | 8 | 25,407 | 0.03 | N/A |
| VOC | Soil | Holding Times | Holding times were exceeded | No | 82 | 25,407 | 0.32 | Representativeness |
| VOC | Soil | Internal Standards | Internal standards did not meet criteria | No | 336 | 25,407 | 1.32 | Accuracy |
| VOC | Soil | Internal Standards | Internal standards did not meet criteria | Yes | 16 | 25,407 | 0.06 | Accuracy |
| VOC | Soil | LCS | LCS recovery criteria were not met | No | 7 | 25,407 | 0.03 | Accuracy |
| VOC | Soil | LCS | LCS recovery criteria were not met | Yes | 4 | 25,407 | 0.02 | Accuracy |
| VOC | Soil | Matrices | MS/MSD precision criteria were not met | No | 30 | 25,407 | 0.12 | Precision |
| VOC | Soil | Matrices | MS/MSD precision criteria were not met | Yes | 4 | 25,407 | 0.02 | Precision |
| VOC | Soil | Matrices | Percent solids < 30 percent | Yes | 5 | 25,407 | 0.02 | Representativeness |
| VOC | Soil | Other | Sample results were not validated due to re-analysis | No | 43 | 25,407 | 0.17 | N/A |
| VOC | Soil | Other | Sample results were not validated due to re-analysis | Yes | 3 | 25,407 | 0.01 | N/A |
| VOC | Soil | Other | See hard copy for further explanation | No | 4 | 25,407 | 0.02 | N/A |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| VOC | Soil | Sample Preparation | Samples were not properly preserved in the field | No | 262 | 25,407 | 1.03 | Representativeness |
| VOC | Soil | Sample Preparation | Samples were not properly preserved in the field | Yes | 6 | 25,407 | 0.02 | Representativeness |
| VOC | Soil | Surrogates | Surrogate recovery criteria were not met | No | 233 | 25,407 | 0.92 | Accuracy |
| VOC | Soil | Surrogates | Surrogate recovery criteria were not met | Yes | 18 | 25,407 | 0.07 | Accuracy |
| VOC | Water | Blanks | Method, preparation, or reagent blank contamination | No | 203 | 67,249 | 0.30 | Representativeness |
| VOC | Water | Blanks | Method, preparation, or reagent blank contamination | Yes | 80 | 67,249 | 0.12 | Representativeness |
| VOC | Water | Calculation Errors | Calculation error | Yes | 7 | 67,249 | 0.01 | N/A |
| VOC | Water | Calibration | Continuing calibration verification criteria were not met | No | 821 | 67,249 | 1.22 | Accuracy |
| VOC | Water | Calibration | Continuing calibration verification criteria were not met | Yes | 140 | 67,249 | 0.21 | Accuracy |
| VOC | Water | Calibration | Independent calibration verification criteria not met | No | 43 | 67,249 | 0.06 | Accuracy |
| VOC | Water | Calibration | Independent calibration verification criteria not met | Yes | 16 | 67,249 | 0.02 | Accuracy |
| VOC | Water | Calibration | Original result exceeded linear range, serial dilution value reported | Yes | 140 | 67,249 | 0.21 | Accuracy |
| VOC | Water | Calibration | Result exceeded linear range of measurement system | Yes | 106 | 67,249 | 0.16 | Accuracy |
| VOC | Water | Confirmation | Results were not confirmed | No | 8 | 67,249 | 0.01 | Precision |
| VOC | Water | Confirmation | Results were not confirmed | Yes | 3 | 67,249 | 0.00 | Precision |
| VOC | Water | Documentation Issues | Information missing from case narrative | No | 162 | 67,249 | 0.24 | N/A |
| VOC | Water | Documentation Issues | Information missing from case narrative | Yes | 3 | 67,249 | 0.00 | N/A |
| VOC | Water | Documentation Issues | Key data fields incorrect | No | 48 | 67,249 | 0.07 | N/A |
| VOC | Water | Documentation Issues | Key data fields incorrect | Yes | 5 | 67,249 | 0.01 | N/A |
| VOC | Water | Documentation Issues | Missing deliverables (not required for validation) | No | 1,398 | 67,249 | 2.08 | N/A |
| VOC | Water | Documentation Issues | Missing deliverables (not required for validation) | Yes | 78 | 67,249 | 0.12 | N/A |
| VOC | Water | Documentation Issues | Missing deliverables (required for validation) | No | 175 | 67,249 | 0.26 | Representativeness |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| VOC | Water | Documentation Issues | Missing deliverables (required for validation) | Yes | 21 | 67,249 | 0.03 | Representativeness |
| VOC | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 5,307 | 67,249 | 7.89 | N/A |
| VOC | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 354 | 67,249 | 0.53 | N/A |
| VOC | Water | Documentation Issues | Omissions or errors in data package (required for validation) | No | 48 | 67,249 | 0.07 | Representativeness |
| VOC | Water | Documentation Issues | Omissions or errors in data package (required for validation) | Yes | 6 | 67,249 | 0.01 | Representativeness |
| VOC | Water | Documentation Issues | Original documentation not provided | No | 54 | 67,249 | 0.08 | N/A |
| VOC | Water | Documentation Issues | Original documentation not provided | Yes | 2 | 67,249 | 0.00 | N/A |
| VOC | Water | Documentation Issues | Record added by the validator | No | 64 | 67,249 | 0.10 | N/A |
| VOC | Water | Documentation Issues | Record added by the validator | Yes | 6 | 67,249 | 0.01 | N/A |
| VOC | Water | Documentation Issues | Sample analysis was not requested | No | 2 | 67,249 | 0.00 | N/A |
| VOC | Water | Documentation Issues | Transcription error | No | 10,761 | 67,249 | 16.00 | N/A |
| VOC | Water | Documentation Issues | Transcription error | Yes | 1,293 | 67,249 | 1.92 | N/A |
| VOC | Water | Holding Times | Holding times were exceeded | No | 3,888 | 67,249 | 5.78 | Representativeness |
| VOC | Water | Holding Times | Holding times were exceeded | Yes | 127 | 67,249 | 0.19 | Representativeness |
| VOC | Water | Holding Times | Holding times were grossly exceeded | No | 1 | 67,249 | 0.00 | Representativeness |
| VOC | Water | Holding Times | Holding times were grossly exceeded | Yes | 46 | 67,249 | 0.07 | Representativeness |
| VOC | Water | Instrument Set-up | Instrument tune criteria were not met | No | 3,196 | 67,249 | 4.75 | Accuracy |
| VOC | Water | Instrument Set-up | Instrument tune criteria were not met | Yes | 216 | 67,249 | 0.32 | Accuracy |
| VOC | Water | Internal Standards | Internal standards did not meet criteria | No | 141 | 67,249 | 0.21 | Accuracy |
| VOC | Water | Internal Standards | Internal standards did not meet criteria | Yes | 16 | 67,249 | 0.02 | Accuracy |
| VOC | Water | LCS | LCS recovery criteria were not met | No | 1,377 | 67,249 | 2.05 | Accuracy |
| VOC | Water | LCS | LCS recovery criteria were not met | Yes | 153 | 67,249 | 0.23 | Accuracy |
| VOC | Water | Matrices | MS/MSD precision criteria were not met | No | 101 | 67,249 | 0.15 | Precision |
| VOC | Water | Matrices | MS/MSD precision criteria were not met | Yes | 16 | 67,249 | 0.02 | Precision |
| VOC | Water | Other | Sample results were not validated due to re-analysis | No | 541 | 67,249 | 0.80 | N/A |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| VOC | Water | Other | Sample results were not validated due to re-analysis | Yes | 256 | 67,249 | 0.38 | N/A |
| VOC | Water | Other | See hard copy for further explanation | No | 554 | 67,249 | 0.82 | N/A |
| VOC | Water | Other | See hard copy for further explanation | Yes | 154 | 67,249 | 0.23 | N/A |
| VOC | Water | Sample Preparation | Preservation requirements were not met by the laboratory | No | 143 | 67,249 | 0.21 | Representativeness |
| VOC | Water | Sample Preparation | Preservation requirements were not met by the laboratory | Yes | 4 | 67,249 | 0.01 | Representativeness |
| VOC | Water | Sample Preparation | Samples were not properly preserved in the field | No | 1,363 | 67,249 | 2.03 | Representativeness |
| VOC | Water | Sample Preparation | Samples were not properly preserved in the field | Yes | 93 | 67,249 | 0.14 | Representativeness |
| VOC | Water | Sensitivity | Instrument detection limit > the associated RDL | No | 3 | 67,249 | 0.00 | Representativeness |
| VOC | Water | Surrogates | Surrogate recovery criteria were not met | No | 810 | 67,249 | 1.20 | Accuracy |
| VOC | Water | Surrogates | Surrogate recovery criteria were not met | Yes | 177 | 67,249 | 0.26 | Accuracy |
| Wet Chem | Soil | Blanks | Calibration verification blank contamination | Yes | 74 | 481 | 15.38 | Representativeness |
| Wet Chem | Soil | Blanks | Method, preparation, or reagent blank contamination | Yes | 2 | 481 | 0.42 | Representativeness |
| Wet Chem | Soil | Calculation Errors | Control limits not assigned correctly | Yes | 17 | 481 | 3.53 | N/A |
| Wet Chem | Soil | Documentation Issues | Key data fields incorrect | Yes | 3 | 481 | 0.62 | N/A |
| Wet Chem | Soil | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 10 | 481 | 2.08 | N/A |
| Wet Chem | Soil | Documentation Issues | Record added by the validator | Yes | 1 | 481 | 0.21 | N/A |
| Wet Chem | Soil | Holding Times | Holding times were exceeded | No | 2 | 481 | 0.42 | Representativeness |
| Wet Chem | Soil | Holding Times | Holding times were exceeded | Yes | 4 | 481 | 0.83 | Representativeness |
| Wet Chem | Soil | LCS | LCS recovery criteria were not met | Yes | 68 | 481 | 14.14 | Accuracy |
| Wet Chem | Soil | Matrices | Duplicate sample precision criteria were not met | No | 5 | 481 | 1.04 | Precision |
| Wet Chem | Soil | Matrices | Predigestion MS recovery criteria were not met | No | 24 | 481 | 4.99 | Accuracy |
| Wet Chem | Soil | Matrices | Predigestion MS recovery criteria were not met | Yes | 79 | 481 | 16.42 | Accuracy |
| Wet Chem | Soil | Matrices | Predigestion MS recovery was < 30 percent | Yes | 112 | 481 | 23.28 | Accuracy |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Wet Chem | Soil | Other | IDL is older than 3 months from date of analysis | Yes | 69 | 481 | 14.35 | Accuracy |
| Wet Chem | Soil | Other | See hard copy for further explanation | No | 11 | 481 | 2.29 | N/A |
| Wet Chem | Water | Blanks | Calibration verification blank contamination | No | 2 | 5,703 | 0.04 | Representativeness |
| Wet Chem | Water | Blanks | Method, preparation, or reagent blank contamination | No | 48 | 5,703 | 0.84 | Representativeness |
| Wet Chem | Water | Blanks | Negative bias indicated in the blanks | No | 43 | 5,703 | 0.75 | Representativeness |
| Wet Chem | Water | Blanks | Negative bias indicated in the blanks | Yes | 27 | 5,703 | 0.47 | Representativeness |
| Wet Chem | Water | Calculation Errors | Control limits not assigned correctly | Yes | 2 | 5,703 | 0.04 | N/A |
| Wet Chem | Water | Calibration | Calibration correlation coefficient did not meet requirements | Yes | 17 | 5,703 | 0.30 | Accuracy |
| Wet Chem | Water | Calibration | Continuing calibration verification criteria were not met | Yes | 5 | 5,703 | 0.09 | Accuracy |
| Wet Chem | Water | Calibration | Result exceeded linear range of measurement system | Yes | 2 | 5,703 | 0.04 | Accuracy |
| Wet Chem | Water | Documentation Issues | Missing deliverables (not required for validation) | Yes | 11 | 5,703 | 0.19 | N/A |
| Wet Chem | Water | Documentation Issues | Missing deliverables (required for validation) | Yes | 10 | 5,703 | 0.18 | Representativeness |
| Wet Chem | Water | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 55 | 5,703 | 0.96 | N/A |
| Wet Chem | Water | Documentation Issues | Record added by the validator | No | 15 | 5,703 | 0.26 | N/A |
| Wet Chem | Water | Documentation Issues | Record added by the validator | Yes | 13 | 5,703 | 0.23 | N/A |
| Wet Chem | Water | Documentation Issues | Transcription error | No | 90 | 5,703 | 1.58 | N/A |
| Wet Chem | Water | Documentation Issues | Transcription error | Yes | 344 | 5,703 | 6.03 | N/A |
| Wet Chem | Water | Holding Times | Holding times were exceeded | No | 31 | 5,703 | 0.54 | Representativeness |
| Wet Chem | Water | Holding Times | Holding times were exceeded | Yes | 49 | 5,703 | 0.86 | Representativeness |
| Wet Chem | Water | Holding Times | Holding times were grossly exceeded | No | 41 | 5,703 | 0.72 | Representativeness |
| Wet Chem | Water | Holding Times | Holding times were grossly exceeded | Yes | 32 | 5,703 | 0.56 | Representativeness |
| Wet Chem | Water | LCS | LCS recovery criteria were not met | No | 2 | 5,703 | 0.04 | Accuracy |
| Wet Chem | Water | Matrices | Duplicate sample precision criteria were not met | No | 2 | 5,703 | 0.04 | Precision |
| Wet Chem | Water | Matrices | Duplicate sample precision criteria were not met | Yes | 9 | 5,703 | 0.16 | Precision |

**Table A2.2**
**Summary of V&V Observations**

| Analyte Group | Matrix | QC Category | V&V Observation | Detect | No. of Records w/ Noted Observation | Total No. of V&V Records | Percent Observed (%) | PARCC Parameter Affected |
|---|---|---|---|---|---|---|---|---|
| Wet Chem | Water | Matrices | LCS/LCSD precision criteria were not met | Yes | 6 | 5,703 | 0.11 | Precision |
| Wet Chem | Water | Matrices | Predigestion MS recovery criteria were not met | No | 52 | 5,703 | 0.91 | Accuracy |
| Wet Chem | Water | Matrices | Predigestion MS recovery criteria were not met | Yes | 175 | 5,703 | 3.07 | Accuracy |
| Wet Chem | Water | Matrices | Predigestion MS recovery was < 30 percent | Yes | 1 | 5,703 | 0.02 | Accuracy |
| Wet Chem | Water | Matrices | Site samples were not used for sample matrix QC | Yes | 1 | 5,703 | 0.02 | Representativeness |
| Wet Chem | Water | Other | Lab results not verified due to unsubmitted data | No | 2 | 5,703 | 0.04 | Representativeness |
| Wet Chem | Water | Other | Lab results not verified due to unsubmitted data | Yes | 45 | 5,703 | 0.79 | Representativeness |
| Wet Chem | Water | Other | QC sample frequency does not meet method requirements | Yes | 2 | 5,703 | 0.04 | Representativeness |
| Wet Chem | Water | Other | See hard copy for further explanation | No | 1 | 5,703 | 0.02 | N/A |
| Wet Chem | Water | Other | See hard copy for further explanation | Yes | 27 | 5,703 | 0.47 | N/A |
| Wet Chem | Water | Sample Preparation | Preservation requirements were not met by the laboratory | No | 1 | 5,703 | 0.02 | Representativeness |
| Wet Chem | Water | Sample Preparation | Preservation requirements were not met by the laboratory | Yes | 9 | 5,703 | 0.16 | Representativeness |
| Wet Chem | Water | Sample Preparation | Sample pretreatment or preparation method was incorrect | Yes | 2 | 5,703 | 0.04 | Representativeness |
| Wet Chem | Water | Sample Preparation | Samples were not properly preserved in the field | Yes | 19 | 5,703 | 0.33 | Representativeness |

**Table A2.3**
**Summary of Data Estimated or Undetected Due to V&V Determinations**

| Analyte Group | Matrix | No. of CRA Data Records Qualified | Total No. of V&V CRA Records | Detect | Percent Qualified (%) |
|---|---|---|---|---|---|
| Herbicide | Soil | 43 | 349 | No | 12.32 |
| Herbicide | Water | 1 | 95 | No | 1.05 |
| Metal | Soil | 1,636 | 12,381 | No | 13.21 |
| Metal | Soil | 2,962 | 12,381 | Yes | 23.92 |
| Metal | Water | 5,637 | 38,884 | No | 14.50 |
| Metal | Water | 2,494 | 38,884 | Yes | 6.41 |
| PCB | Soil | 193 | 1,882 | No | 10.26 |
| PCB | Soil | 5 | 1,882 | Yes | 0.27 |
| Pesticide | Soil | 264 | 2,688 | No | 9.82 |
| Pesticide | Soil | 3 | 2,688 | Yes | 0.11 |
| Pesticide | Water | 7 | 1,377 | No | 0.51 |
| Radionuclide | Soil | 28 | 3,541 | No | 0.79 |
| Radionuclide | Soil | 127 | 3,541 | Yes | 3.59 |
| Radionuclide | Water | 46 | 9,345 | No | 0.49 |
| Radionuclide | Water | 173 | 9,345 | Yes | 1.85 |
| SVOC | Soil | 435 | 18,490 | No | 2.35 |
| SVOC | Soil | 46 | 18,490 | Yes | 0.25 |
| SVOC | Water | 569 | 7,226 | No | 7.87 |
| SVOC | Water | 15 | 7,226 | Yes | 0.21 |
| VOC | Soil | 989 | 25,407 | No | 3.89 |
| VOC | Soil | 185 | 25,407 | Yes | 0.73 |
| VOC | Water | 7,006 | 67,249 | No | 10.42 |
| VOC | Water | 640 | 67,249 | Yes | 0.95 |
| Wet Chem | Soil | 32 | 481 | No | 6.65 |
| Wet Chem | Soil | 237 | 481 | Yes | 49.27 |
| Wet Chem | Water | 188 | 5,703 | No | 3.30 |
| Wet Chem | Water | 351 | 5,703 | Yes | 6.15 |
| | **Total** | **24,312** | **195,609** | | **12.43%** |

**Table A2.4**
**Summary of Data Qualified as Undetected Due to Blank Contamination**

| Analyte Group | Matrix | No. of CRA Records Qualified as Undetected Due to Blank Contaimination | Total No. of CRA Records with Detected Results[a] | Percent Qualified as Undetected |
|---|---|---|---|---|
| Metal | Soil | 289 | 9,304 | 3.11 |
| Metal | Water | 597 | 16,993 | 3.51 |
| PCB | Soil | 1 | 75 | 1.33 |
| Radionuclide | Soil | 1 | 2,975 | 0.03 |
| VOC | Soil | 16 | 746 | 2.14 |
| VOC | Water | 9 | 4,568 | 0.20 |
| | **Total** | **913** | **34,661** | **2.63%** |

[a] As determined by the laboratory prior to V&V.

**Table A2.5**
**Summary of RPDs/DERs of Field Duplicate Analyte Pairs**

| Analyte Group | Matrix | No. of Duplicates Failing RPD/DER Criteria | Total No. of Duplicate Pairs | Percent Failure (%) | Field Duplicate Frequency (%) |
|---|---|---|---|---|---|
| Dioxins and Furans | Water | 0 | 7 | 0.00 | 12.50 |
| Herbicide | Soil | 0 | 24 | 0.00 | 6.19 |
| Herbicide | Water | 0 | 10 | 0.00 | 10.42 |
| Metal | Soil | 106 | 1,135 | 9.34 | 8.36 |
| Metal | Water | 57 | 2,703 | 2.11 | 6.57 |
| PCB | Soil | 0 | 161 | 0.00 | 8.24 |
| PCB | Water | 0 | 42 | 0.00 | 9.09 |
| Pesticide | Soil | 0 | 263 | 0.00 | 8.95 |
| Pesticide | Water | 0 | 128 | 0.00 | 9.15 |
| Radionuclide | Soil | 50 | 462 | 10.82 | 11.11 |
| Radionuclide | Water | 15 | 818 | 1.83 | 7.55 |
| SVOC | Soil | 1 | 1,461 | 0.07 | 6.97 |
| SVOC | Water | 0 | 663 | 0.00 | 8.61 |
| VOC | Soil | 1 | 1,801 | 0.06 | 6.82 |
| VOC | Water | 99 | 6,298 | 1.57 | 8.29 |
| Wet Chem | Soil | 0 | 50 | 0.00 | 9.03 |
| Wet Chem | Water | 11 | 417 | 2.64 | 6.93 |

**Table A2.6**
**Summary of Data Rejected During V&V**

| Analyte Group | Matrix | Total No. of Rejected Records | Total No. of V&V Records | Percent Rejected (%) |
|---|---|---|---|---|
| Dioxins and Furans | Water | 0 | 56 | 0.00 |
| Herbicide | Soil | 7 | 599 | 1.17 |
| Herbicide | Water | 2 | 118 | 1.69 |
| Metal | Soil | 380 | 23,768 | 1.60 |
| Metal | Water | 846 | 47,428 | 1.78 |
| PCB | Soil | 7 | 3,108 | 0.23 |
| PCB | Water | 0 | 581 | 0.00 |
| Pesticide | Soil | 32 | 5,800 | 0.55 |
| Pesticide | Water | 0 | 1,764 | 0.00 |
| Radionuclide | Soil | 881 | 45,963 | 1.92 |
| Radionuclide | Water | 841 | 12,380 | 6.79 |
| SVOC | Soil | 667 | 31,146 | 2.14 |
| SVOC | Water | 237 | 8,495 | 2.79 |
| VOC | Soil | 1,823 | 55,136 | 3.31 |
| VOC | Water | 2,984 | 84,190 | 3.54 |
| Wet Chem | Soil | 21 | 1,293 | 1.62 |
| Wet Chem | Water | 113 | 7,201 | 1.57 |
| | **Total** | **8,841** | **329,026** | **2.69%** |

**Table A2.7**
**Summary of Data Quality Issues Identified by V&V**

| Analyte Group | Matrix | Categories Description | V&V Observation | Detect | Percent Observed | Percent Qualified U[a] | Percent Qualified J[b] | PARCC Parameter Affected | Impacts Risk Management Decision |
|---|---|---|---|---|---|---|---|---|---|
| Herbicide | | Calibration | Continuing calibration verification criteria were not met | No | 8.02 | 8.02 | 0.00 | Accuracy | No |
| Metal | Soil | LCS | LCS recovery criteria were not met | Yes | 6.01 | 0.00 | 5.88 | Accuracy | No |
| Metal | Soil | Matrices | Predigestion MS recovery criteria were not met | Yes | 8.81 | 0.00 | 8.42 | Accuracy | No |
| Metal | Soil | Other | IDL is older than 3 months from date of analysis | Yes | 12.85 | 0.00 | 2.48 | Accuracy | No |
| Metal | Water | Blanks | Method, preparation, or reagent blank contamination | No | 7.66 | 0.01 | 7.65 | Representativeness | No |
| PCB | Soil | Calibration | Continuing calibration verification criteria were not met | No | 5.95 | 5.95 | 0.00 | Accuracy | No |
| PCB | Soil | Sample Preparation | Samples were not properly preserved in the field | No | 7.12 | 0.00 | 0.00 | Representativeness | No |
| PCB | Soil | Surrogates | Surrogate recovery criteria were not met | No | 6.91 | 1.49 | 1.43 | Accuracy | No |
| Pesticide | Soil | Holding Times | Holding times were exceeded | No | 8.37 | 0.71 | 5.32 | Representativeness | No |
| Radionuclide | Soil | Calibration | Continuing calibration verification criteria were not met | Yes | 6.27 | 0.00 | 0.00 | Accuracy | No |
| Radionuclide | Soil | Documentation Issues | Sufficient documentation not provided by the laboratory | Yes | 7.17 | 0.00 | 0.03 | Representativeness | No |
| Radionuclide | Soil | Matrices | Replicate precision criteria were not met | Yes | 5.59 | 0.00 | 0.06 | Precision | No |
| Radionuclide | Water | Blanks | Method, preparation, or reagent blank contamination | Yes | 6.69 | 0.00 | 0.82 | Representativeness | No |
| Radionuclide | Water | Calibration | Continuing calibration verification criteria were not met | Yes | 9.40 | 0.00 | 0.42 | Accuracy | No |
| Radionuclide | Water | Documentation Issues | Sufficient documentation not provided by the laboratory | Yes | 8.62 | 0.00 | 0.14 | Representativeness | No |
| VOC | Water | Holding Times | Holding times were exceeded | No | 5.78 | 4.10 | 1.68 | Representativeness | No |
| Wet Chem | Soil | Blanks | Calibration verification blank contamination | Yes | 15.38 | 0.00 | 15.18 | Representativeness | No |
| Wet Chem | Soil | LCS | LCS recovery criteria were not met | Yes | 14.14 | 0.00 | 14.14 | Accuracy | No |
| Wet Chem | Soil | Matrices | Predigestion MS recovery criteria were not met | Yes | 16.42 | 0.00 | 16.42 | Accuracy | No |
| Wet Chem | Soil | Matrices | Predigestion MS recovery was < 30 percent | Yes | 23.28 | 0.00 | 23.28 | Accuracy | No |
| Wet Chem | Soil | Other | IDL is older than 3 months from date of analysis | Yes | 14.35 | 0.00 | 13.10 | Accuracy | No |

[a]Defined as validation qualifier codes containing "U"
[b]Defined as validation qualifier codes containing "J", except "UJ"

# COMPREHENSIVE RISK ASSESSMENT

## WIND BLOWN AREA EXPOSURE UNIT

## VOLUME 9: ATTACHMENT 3

## Statistical Analyses and Professional Judgment

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AL | action level |
| CDH | Colorado Department of Health |
| COC | contaminant of concern |
| CRA | Comprehensive Risk Assessment |
| DOE | U.S. Department of Energy |
| ECOI | ecological contaminant of interest |
| EcoSSL | Ecological Soil Screening Level |
| ECOPC | ecological contaminant of potential concern |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| ERA | Ecological Risk Assessment |
| ESL | ecological screening level |
| EU | Exposure Unit |
| HHRA | Human Health Risk Assessment |
| IAEU | Industrial Area Exposure Unit |
| IHSS | Individual Hazardous Substance Site |
| µg/kg | microgram per kilogram |
| MDC | maximum detected concentration |
| mg/kg | milligrams per kilogram |
| N/A | Not Applicable |
| NCP | National Contingency Plan |
| NFA | No Further Action |
| NOAEL | no observed adverse effect level |

| | |
|---|---|
| PCB | polychlorinated biphenyl |
| pCi/g | picocuries per gram |
| PCOC | potential contaminant of concern |
| PMJM | Preble's meadow jumping mouse |
| PRG | preliminary remediation goal |
| RFETS | Rocky Flats Environmental Technology Site |
| RI/FS | Remedial Investigation/Feasibility Study |
| RLCR | Reconnaissance-Level Characterization Reports |
| tESL | threshold ESL |
| UCL | upper confidence limit |
| UTL | upper tolerance limit |
| WBEU | Wind Blown Area Exposure Unit |
| WRS | Wilcoxon Rank Sum |
| WRW | wildlife refuge worker |

## 1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Wind Blown Area Exposure Unit (EU) (WBEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

## 2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE WIND BLOWN AREA EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the WBEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.26.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the interquartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

ECOIs for surface soil (Preble's meadow jumping mouse [PMJM] receptor) and PCOCs with concentrations that are statistically greater than background (or those where background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. There are small portions of several PMJM patches within WBEU; however, these patches are evaluated in either LWOEU or UWNEU. Therefore, no ECOIs for surface soil PMJM are evaluated in this document. ECOIs (for non-PMJM receptors) with concentrations in the WBEU that are

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are non-detections; 2) background data are unavailable; 3) the analyte has low detection frequency in the WBEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

statistically greater than background (or those where background comparisons were not performed) are carried through to the upper-bound exposure point concentration (EPC) – threshold ecological screening level (tESL) comparison step of the ECOPC selection processes.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

## 2.1 Surface Soil/Surface Sediment Data Used in the HHRA

For the WBEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) and upper confidence limits on the mean (UCLs) for arsenic, cesium-137, plutonium-239/240, and radium-228 exceed the wildlife refuge worker (WRW) preliminary remediation goals (PRGs) for the WBEU data set. These PCOCs were carried forward into the statistical background comparison step.

The WBEU MDC for aluminum, chromium, manganese, benzo(a)pyrene, Aroclor-1254, Americium-241, and cesium-134 exceed the PRG, but the UCL for the WBEU data set does not exceed the PRG, and these analytes were not evaluated further. The WBEU MDCs for all other PCOCs do not exceed the PRGs and were not further evaluated.

The results of the statistical comparison of the WBEU surface soil/surface sediment data to background data for the PCOCs are presented in Table A3.2.1 and the summary statistics for background and WBEU surface soil/surface sediment data are shown in Table A3.2.2.

The results of the statistical comparisons of the WBEU surface soil/surface sediment data to background data indicate the following:

***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- Arsenic
- Plutonium-239/240
- Radium-228

***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Cesium-137

***Background Comparison Not Performed[1]***

- None

## 2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

For the WBEU subsurface soil/subsurface sediment data set, the MDCs and UCLs on the mean for radium-228 exceed the WRW PRGs for the WBEU data set, and this PCOC was carried forward into the statistical background comparison step.

The WBEU MDC for chromium, lead, benzo(a)pyrene, americium-241, and plutonium-239/240 exceed the PRG, but the UCL for the WBEU data set does not exceed the PRG, and these analytes were not further evaluated. The WBEU MDCs for all other PCOCs do not exceed the PRGs and were not further evaluated.

The results of the statistical comparison of the WBEU subsurface soil/subsurface sediment data to background data for radium-228 are presented in Table A3.2.3, and the summary statistics for background and WBEU surface soil/surface sediment data are shown in Table A3.2.4.

The results of the statistical comparisons of the WBEU surface soil/surface sediment data to background data indicate the following:

***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- None

***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Radium-228

***Background Comparison Not Performed[1]***

- None

## 2.3 Surface Soil Data Used In the ERA (Non-PMJM)

For the ECOIs in surface soil, the MDCs for aluminum, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, molybdenum, nickel, silver, thallium, tin, uranium, vanadium, and zinc exceed a non-PMJM (ESL), and these ECOIs were carried forward into the statistical background comparison step. The MDCs for benzo(a)pyrene, bis(2-ethylhexyl)phthalate, endrin, and polychlorinated biphenyl total PCB also exceed a non-PMJM ESL. The MDC for di-n-butylphthalate exceeded a non-PMJM ESL, but because the detection frequency of this organic compound was less than 1 percent, di-n-butylphthalate was eliminated from further evaluation and was not carried forward into the background comparison step.

The results of the statistical comparison of the WBEU surface soil data to background data are presented in Table A3.2.5, and the summary statistics for background and WBEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the WBEU surface soil to background data indicate the following:

***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- Aluminum
- Barium
- Chromium
- Lithium
- Manganese
- Nickel

***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Arsenic
- Cadmium
- Cobalt
- Copper
- Lead
- Mercury
- Vanadium
- Zinc

***Background Comparison Not Performed[1]***

- Boron
- Molybdenum
- Silver
- Thallium
- Tin
- Uranium

## 2.4 Surface Soil Data Used in the ERA (PMJM)

There are small portions of several PMJM patches within WBEU; however, these patches are evaluated in either LWOEU or UWNEU.

## 2.5 Subsurface Soil Data Used in the ERA

For the ECOIs in subsurface soil, the MDCs for antimony, arsenic, chromium, lead, mercury, molybdenum, nickel, and tin exceed the prairie dog ESL and were carried forward into the statistical background comparison step. The MDCs for all other ECOIs do not exceed the prairie dog ecological screening level (ESL). The results of the statistical comparison of the WBEU subsurface soil data to background data are presented in Table A3.2.7 and the summary statistics for background and WBEU subsurface soil data are shown in Table A3.2.8.

The results of the statistical comparisons of the surface soil data to background data indicate the following:

***Analytes Statistically Greater than Background at the 0.1 Significance Level***

- None

***Analytes Not Statistically Greater than Background at the 0.1 Significance Level***

- Arsenic
- Chromium
- Lead
- Mercury
- Molybdenum
- Nickel
- Tin

***Background Comparison Not Performed[1]***

- Antimony

## 3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOIs in surface soil and subsurface soil with concentrations that are statistically greater than background, or background comparisons were not performed, are evaluated further by comparing the WBEU EPCs to the tESLs. The EPCs are the 95 percent UCLs of the 90th percentile [upper tolerance limit (UTL)] for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

### 3.1 ECOIs in Surface Soil

Of the sixteen ECOIs in surface soil for non-PMJM (aluminum, barium, boron, chromium, lithium, manganese, molybdenum, nickel, silver, thallium, tin, uranium, benzo[a]pyrene, bis[2-ethylhexyl]phthalate, endrin, and PCB [total]), only uranium and benzo[a]pyrene were eliminated from further consideration because their EPCs are not greater than the limiting tESLs.

Fourteen ECOIs (aluminum, barium, boron, chromium, lithium, manganese, molybdenum, nickel, silver, thallium, and tin, along with three organics, bis[2-ethylhexyl]phthalate, endrin, and PCB [total]), have EPCs greater than the limiting tESLs and are evaluated in the professional judgment evaluation screening step (Section 4.0).

### 3.2 ECOIs in Subsurface Soil

A background comparison analysis could not be performed for antimony concentrations in subsurface soil at WBEU and this ECOI was evaluated further by comparing the WBEU EPC for antimony to the limiting tESLs. Antimony does not have an EPC greater than the limiting tESL; thus antimony in subsurface soil at WBEU is not carried forward into the professional judgment evaluation screening step.

## 4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS

[2] The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, the absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations

background and regional background data sets (see Table A3.4.1 for a summary of regional background data)[3], and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above are included in the discussion.

For metals, Appendix A, Volume 2, Attachment 8 of the RI/FS Report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for RCEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic
  - Plutonium-239/240
  - Radium-228
- Subsurface soil/subsurface sediment (HHRA)
  - None
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Barium
  - Boron
  - Chromium
  - Lithium
  - Manganese

associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

[3] The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984), and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the Colorado and bordering states background data set is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states provides regional benchmarks for naturally-occurring metals in soil. The comparison of RFETS's soil data to these regional benchmarks is only performed for non-PMJM professional judgment because the PMJM habitat is restricted to the front range of Colorado.

  - Molybdenum
  - Nickel
  - Silver
  - Thallium
  - Tin
  - bis(2-Ethylhexyl)phthalate
  - Endrin
  - Total PCBs
- Subsurface soil (ERA)
  - None

The following sections provide the professional judgment evaluations, by analyte and by medium, for the PCOCs/ECOIs listed above.

## 4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if aluminum should be retained for risk characterization are summarized below.

### 4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, because there was a large inventory of aluminum and it was present in waste generated during former RFETS operations, aluminum may be present in RFETS soil as a result of historical site-related activities. However, these historical source areas are remote from the WBEU.

### 4.1.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in WBEU surface soil reflect variations in naturally occurring aluminum.

### 4.1.3 Pattern Recognition

***Surface Soil (Non-PMJM)***

The probability plot for the natural log-transformed data set for aluminum in surface soil within the WBEU (Figure A3.4.1) is a classical, fully defined, single background population. This background population has a crude “S” shape formed by low concentrations asymptotically tailing off to a low concentration, essentially a straight line forming the majority of the background population, and an upper concentration trend asymptotically tailing off to a high concentration. The lower concentration trend is commonly the detection limit but, in this case, probably represents an approach to a lower limit (about 0.5 percent aluminum). The upper concentration trend is usually a saturation concentration (in this case, 3.2 to 3.3 percent aluminum).

### 4.1.4 Comparison to RFETS Background and Other Background Data Sets

***Surface Soil (Non-PMJM)***

Aluminum was detected in 100 percent of the 151 surface soil samples collected in the WBEU. Aluminum concentrations in surface soil samples at the WBEU range from 4,780 to 33,000 milligrams per kilogram (mg/kg), with a mean concentration of 14,613 mg/kg and a standard deviation of 6,893 mg/kg. Aluminum concentrations in the background data set range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.6) The concentrations of aluminum in surface soil samples at the WBEU are elevated compared to background, but the data populations overlap.

Aluminum concentrations in WBEU surface soil are well within aluminum background concentrations in soils of Colorado and the bordering states, which range from 5,000 to 100,000 mg/kg, with a mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg (Table A3.4.1).

### 4.1.5 Risk Potential for Plants and Wildlife

***Surface Soil (Non-PMJM)***

The MDC for aluminum in the WBEU (33,000 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, U.S. Environmental Protection Agency (EPA) Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum should not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2. Therefore, aluminum concentrations in WBEU surface soil are unlikely to result in risk concerns for wildlife populations.

### 4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests aluminum is naturally occurring; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; WBEU aluminum concentrations that are well within regional background levels; and WBEU concentrations that are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an

ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

## 4.2 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained as a COC for risk characterization are summarized below.

### 4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that arsenic cannot be eliminated as a PCOC in WBEU soil due to the presence of the Individual Hazardous Substance Site (IHSS) SE-1602 in the WBEU, a former firing range.

### 4.2.2 Evaluation of Spatial Trends

***Surface Soil/Surface Sediment***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, arsenic in surface soil/surface sediment cannot be eliminated as a COC in the WBEU because elevated concentrations of arsenic are located near historical IHSSs and will be evaluated in the risk characterization for the WBEU.

### 4.2.3 Conclusion

The weight of evidence presented above shows that arsenic concentrations in WBEU surface soil/surface sediment may be associated with past site activities and cannot be eliminated as a COC. Therefore, arsenic is carried forward into risk characterization.

## 4.3 Barium

Barium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if barium should be retained for risk characterization are summarized below.

### 4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that barium is unlikely to be present in RFETS soil as a result of historical site-related activities.

### 4.3.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that barium concentrations in WBEU surface soil reflect variations in naturally occurring barium.

### 4.3.3 Pattern Recognition

***Surface Soil (Non-PMJM)***

The probability plot for barium in surface soil (Figure A3.4.2) indicates the presence of a single background population.

### 4.3.4 Comparison to RFETS Background and Other Background Data Sets

***Surface Soil (Non-PMJM)***

Barium concentrations in WBEU surface soil range from 34.9 to 280 mg/kg, with a mean concentration of 135 mg/kg and a standard deviation of 47.3 mg/kg. Barium concentrations in the background data set range from 45.7 to 134.0 mg/kg, with a mean concentration of 102.0 and a standard deviation of 19.4 mg/kg (Table A3.2.6). The concentrations of barium in surface soil samples at the WBEU are slightly elevated compared to background, but the data populations do overlap considerably.

Barium concentrations in WBEU surface soil are well within the range for background concentrations of barium in soils of Colorado and the bordering states, which range from 100.0 to 3,000 mg/kg, with mean concentration of 642 mg/kg and a standard deviation of 330 mg/kg (Table A3.4.1).

### 4.3.5 Risk Potential for Plants and Wildlife

***Surface Soil (Non-PMJM)***

The UTL for barium in the WBEU (230 mg/kg) exceeds the NOAEL ESL of only one receptor group, the herbivorous mourning dove (159 mg/kg). The NOAEL ESLs for all other non-PMJM receptors were greater than the UTL. The UTL of 230 mg/kg is also less than the Eco-SSL for soil invertebrates (330 mg/kg) and mammals (2,000 mg/kg) (EPA 2005). No barium Eco-SSLs are currently available for plants or birds.

### 4.3.6 Conclusion

The weight of evidence presented above shows that barium concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; the spatial distribution analysis that suggests barium is naturally occurring; and the pattern recognition analysis that indicates the presence of a single background population within WBEU surface soil. In addition, barium concentrations within WBEU are well within regional background levels. Therefore, barium is not considered an ECOPC in surface soil for the WBEU and is not further evaluated quantitatively.

## 4.4 Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if bis(2-ethylhexyl)phthalate should be retained for risk characterization are summarized below.

### 4.4.1 Summary of Process Knowledge

There are no documented historical source areas present in the WBEU, and no documented operations or activities that occurred in the WBEU involving the use of bis(2-ethylhexyl)phthalate (Colorado Department of Health [CDH] 1992; U.S. Department of Energy [DOE] 1992, 1995). Therefore, the potential for bis(2-ethylhexyl)phthalate to be present in WBEU surface soil as a result of historical site-related activities is unlikely.

### 4.4.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

Bis(2-ethylhexyl)phthalate was detected in 11 percent of the WBEU surface soil samples. The detections are estimated values, and most results are below the reported detection limits of 330 to 480 micrograms per kilogram (μg/kg). However, the bis(2-ethylhexyl)phthalate MDC of 580 μg/kg was above the upper detection limit. As shown in Figure A3.4.3, there are two locations near a historical IHSS that have concentrations of bis(2-ethylhexyl)phthalate greater than three times the ESL.

### 4.4.3 Conclusion

Although there are no documented historical source areas of bis(2-ethylhexyl)phthalate present in the WBEU and the EPA considers bis(2-ethylhexyl)phthalate, along with other phthalate esters, to be common laboratory contaminants, a decision could not be made whether the elevated concentration in the samples collected from the WBEU is significantly elevated compared to background because the background comparison is not performed for organics. Because the bis(2-ethylhexyl)phthalate MDC of 510 μg/kg exceeded two NOAEL ESL, insectivorous mourning dove (137 μg/kg) and American kestrel (398 μg/kg), and the UTL of 395 μg/kg exceeded the NOAEL ESL for insectivorous mourning dove (137 μg/kg), as a conservative measure, bis(2-ethylhexyl)phthalate was identified as an ECOPC and carried forward into risk characterization.

## 4.5 Boron

For boron in surface soil, a statistical comparison between WBEU and RFETS background data could not be performed because RFETS background surface soil samples were not analyzed for boron. Boron has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

### 4.5.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

### 4.5.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in WBEU surface soil reflect variations in naturally occurring boron.

### 4.5.3 Pattern Recognition

***Surface Soil (Non-PMJM)***

The probability plot for boron in surface soil (Figure A3.4.4) indicates the presence of a single background population.

### 4.5.4 Comparison to RFETS Background and Other Background Data Sets

***Surface Soil (Non-PMJM)***

The reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg (Table A3.4.1). Boron concentrations reported in surface soil samples at the WBEU range from 0.67 to 15.0 mg/kg, with a mean concentration of 6.82 mg/kg and a standard deviation of 3.63 mg/kg (Table A3.2.6). The range of concentrations of boron in surface soil is well within the lower range for background concentrations for boron in soils of Colorado and the bordering states.

### 4.5.5 Risk Potential for Plants and Wildlife

***Surface Soil (Non-PMJM)***

The UTL for boron in the WBEU (13.0 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and because risks are not typically expected at background concentrations, boron concentrations are not likely to be indicative of site-related risk to the terrestrial plant community in the WBEU. Kabata-Pendias and Pendias (1992) indicate that soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before addition. The confidence placed by Efroymson et al. (1997) was low. No boron Eco-SSLs are currently available. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is unlikely to present a risk to terrestrial receptor populations in the WBEU.

### 4.5.6 Conclusion

The weight of evidence presented above shows that boron concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests boron is naturally occurring; and a probability plot that suggests the presence of a single population, which is also indicative of background conditions. In addition, WBEU boron concentrations are well within regional background levels and WBEU concentrations are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

## 4.6 Chromium

Chromium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if chromium should be retained for risk characterization are summarized below.

### 4.6.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for chromium to have been released into RFETS soil because of the moderate chromium metal inventory and the presence of chromium in waste generated during former operations. Spills of chromium-contaminated wastes have also occurred at RFETS. Based on process knowledge, chromium may be present in RFETS soil as a result of historical site-related activities.

### 4.6.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis shows the concentrations of chromium at levels three times the background MDC at several locations in the WBEU that are near historical IHSSs.

### 4.6.3 Conclusion

The weight of evidence presented above shows that chromium concentrations in WBEU surface soil (non-PMJM) may be a result of historical site-related activities based on process knowledge and the spatial distribution analysis. Therefore, based on this line of evidence, chromium in surface soil is considered an ECOPC and is evaluated in the risk characterization.

## 4.7 Endrin

Endrin has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if endrin should be retained for risk characterization are summarized below.

### 4.7.1 Summary of Process Knowledge

There are no documented operations or activities that occurred in the WBEU involving the use of endrin (CDH 1992; DOE 1992, 1995). Therefore, the potential for endrin to be present in WBEU surface soil as a result of historical site-related activities is unlikely.

### 4.7.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

Endrin is not a naturally occurring compound and a background comparison can not be performed. Endrin was detected in only 8 percent of the 40 surface soil samples collected within the WBEU. Endrin concentrations ranged from 4.50 to 5.10 µg/kg. The three locations where endrin concentrations were greater than three times the ESL were clustered together near an IHSS (Figure A3.4.5). Therefore endrin cannot be eliminated as an ECOPC.

### 4.7.3 Conclusion

Due to the elevated concentrations of endrin at three locations within the WBEU located near historical IHSSs, endrin was identified as an ECOPC and carried forward into risk characterization.

## 4.8 Lithium

Lithium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained for risk characterization are summarized below.

### 4.8.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lithium to have been released into RFETS soil because of the moderate lithium metal inventory and presence of lithium in waste generated during former operations. However, these sources of historical use are remote from the WBEU. Therefore, lithium may be present in RFETS soil as a result of historical site-related activities.

### 4.8.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that lithium concentrations in WBEU surface soil reflect variations in naturally occurring lithium.

### 4.8.3 Pattern Recognition

***Surface Soil (Non-PMJM)***

The probability plot for lithium concentrations suggests the presence of a single population, which indicates background conditions (Figure A3.4.6).

### 4.8.4 Comparison to RFETS Background and Other Background Data Sets

***Surface Soil (Non-PMJM)***

Lithium concentrations in surface soil samples at the WBEU range from 4.40 to 33.0 mg/kg, with a mean concentration of 12.4 mg/kg and a standard deviation of 6.26 mg/kg. Lithium concentrations in the background data set range from 4.80 to 11.6 mg/kg, with a mean concentration of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6). The concentrations of lithium in surface soil samples at the WBEU are slightly elevated compared to background, but the data populations do overlap.

Lithium concentrations reported in surface soil samples at the WBEU are well within the range for lithium in soils of Colorado and the bordering states (5 to 130 mg/kg, with mean concentration of 25.3 mg/kg and a standard deviation of 14.4 mg/kg) (Table A3.4.1).

### 4.8.5 Risk Potential for Plants and Wildlife

***Surface Soil (Non-PMJM)***

The UTL for lithium in the WBEU (23.3 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 610 to 18,431 mg/kg. The ESL for terrestrial plants is lower than all detected background concentrations. None of the NOAEL ESLs for mammalian receptors are exceeded by the LWNEU surface soil lithium MDC. NOAEL ESLs were not available for avian receptors due to lack of toxicity information. The authors of the document from which the lithium NOAEL ESL was selected (Efroymson et al. 1997) placed a low confidence rating on the value. Other studies reported in Efroymson et al. (1997) cited no observed adverse effects at 25 mg/kg, which is greater than the MDC. Only a highly conservative and uncertain ESL for terrestrial plants was exceeded. No lithium Eco-SSLs are currently available.

### 4.8.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in WBEU surface soil (non-PMJM receptors) have a spatial distribution indicative of naturally occurring lithium; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; and WBEU concentrations that are well within regional background levels. Lithium is not considered an ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

## 4.9 Manganese

Manganese has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and was carried forward to the professional judgment step. The lines of evidence used to determine if manganese should be retained for risk characterization are summarized below.

### 4.9.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates manganese is unlikely to be present in RFETS soil as a result of historical site-related activities.

### 4.9.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that manganese concentrations in some locations within the WBEU exceed the ESL and background, but are at levels less than three times the minimum ESL. However, because these locations are near historical IHSSs, manganese in surface soil within the WBEU cannot be eliminated as an ECOPC and is evaluated in the risk characterization.

### 4.9.3 Conclusion

The weight of evidence presented above shows that manganese concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge. However, the spatial distribution analysis indicates that elevated manganese concentrations within the WBEU are located near historical IHSSs. Therefore, manganese in surface soil (non-PMJM) was identified as an ECOPC and carried forward into risk characterization.

## 4.10 Molybdenum

For molybdenum in surface soil, a statistical comparison between WBEU and RFETS background data could not be performed because molybdenum was not detected in RFETS background surface soil samples. Molybdenum had an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if molybdenum should be retained for risk characterization are summarized below.

### 4.10.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates molybdenum is unlikely to be present in RFETS soil as a result of historical site-related activities.

### 4.10.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that molybdenum concentrations in WBEU surface soil reflect variations in naturally occurring molybdenum.

### 4.10.3 Pattern Recognition

***Surface Soil (Non-PMJM)***

The probability plot for molybdenum contain a large proportion of censored data with multiple detection limits, resulting in “stair-steps” as shown in Figure A3.4.7, which does not indicate a single background population.

### 4.10.4 Comparison to RFETS Background and Other Background Data Sets

***Surface Soil (Non-PMJM)***

The reported range for molybdenum in surface soil within Colorado and the bordering states is 3 to 7 mg/kg, with a mean concentration of 1.59 mg/kg and a standard deviation of 0.522 mg/kg (Table A3.4.1). Molybdenum concentrations reported in surface soil samples at the WBEU range from 0.150 to 3.0 mg/kg, with a mean concentration of 1.07 mg/kg and a standard deviation of 1.00 mg/kg (Table A3.2.6). The range of concentrations of molybdenum in surface soil is below the range for molybdenum in soils of Colorado and the bordering states.

### 4.10.5 Risk Potential for Plants and Wildlife

***Surface Soil (Non-PMJM)***

The UTL for molybdenum in the WBEU (2.50 mg/kg) exceeds the NOAEL ESL for two receptor groups: terrestrial plants (2.0 mg/kg) and insectivorous deer mouse (1.90 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 7.0 to 275.0 mg/kg. Only the ESL for terrestrial plants is within the range of background concentrations. No molybdenum Eco-SSLs are currently available.

### 4.10.6 Conclusion

The weight of evidence presented above shows that molybdenum concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, a spatial distribution that suggests molybdenum is naturally occurring, and WBEU concentrations that are well within regional background levels. Although the probability plot does not indicate the presence of a single background population, molybdenum is not considered an ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

## 4.11 Nickel

Nickel had an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if nickel should be retained for risk characterization are summarized below.

### 4.11.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for nickel to have been released into RFETS soil because of the moderate nickel metal inventory and presence of nickel in waste generated during former operations. Based on process knowledge, nickel may be present in RFETS soil as a result of historical site-related activities.

#### 4.11.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that nickel in surface soil cannot be eliminated as an ECOPC for the WBEU and is evaluated in the risk characterization.

#### 4.11.3 Conclusion

The weight of evidence presented above shows that nickel concentrations in surface soil within WBEU may be a result of historical site-related activities based on process knowledge. The spatial distribution analysis indicates that elevated nickel concentrations within the WBEU are located near historical IHSSs. Therefore, nickel in surface soil (non-PMJM) was identified as an ECOPC and carried forward into risk characterization.

### 4.12 Total PCBs

Total PCBs has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. A decision could not be made whether concentrations in samples collected from EU are significantly elevated versus background because the background comparison is not performed for organics. The lines of evidence used to determine if total PCBs should be retained for risk characterization are summarized below.

#### 4.12.1 Summary of Process Knowledge

There are no documented operations or activities that occurred in the WBEU involving the use of total PCBs (CDH 1992; DOE 1992, 1995). Therefore, the potential for total PCBs to be present in WBEU surface soil as a result of historical site-related activities is unlikely.

#### 4.12.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

Total PCBs was detected in 32 percent of the 81 surface samples collected from the WBEU, with a concentration range of 20.1 µg/kg to 3,365 µg/kg, a mean concentration of 184.0 µg/kg, and a standard deviation of 382 µg/kg. Samples with concentrations three times the ESL of 42 µg/kg are located near a historical IHSS (Figure A3.4.8). Therefore, based on this line of evidence, total PCBs cannot be eliminated as an ECOPC.

#### 4.12.3 Conclusion

Total PCB in surface soil concentrations is being carried forward into the ecological non-PMJM risk characterization as an ECOPC because of elevated concentrations (greater than three times the ESL) in surface soil samples collected near historical IHSSs.

## 4.13 Plutonium-239/240

Plutonium-239/240 has concentrations statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if plutonium-239/240 should be retained for risk characterization are summarized below.

### 4.13.1 Summary of Process Knowledge

Components for nuclear weapons were fabricated in a large industrial complex at RFETS from plutonium, uranium, and metals such as beryllium and stainless steel. Other activities of RFETS included purification of plutonium.

### 4.13.2 Evaluation of Spatial Trends

***Surface Soil/Surface Sediment***

Plutonium-239/240 was detected in all of the 319 surface soil/surface sediment samples collected from the WBEU with activities ranging from -0.003 to 49.0 pCi/g, with a mean activity of 9.19 pCi/g and a standard deviation of 12 pCi/g. Samples with concentrations three times the WRW PRG of 29.4 pCi/g are located near historical IHSSs (Figure A3.4.9). Therefore, plutonium-239/240 cannot be eliminated as a COC.

### 4.13.3 Conclusion

Plutonium-239/240 in surface soil/surface sediment is being carried forward into the risk characterization as a COC because elevated concentrations (greater than three times the ESL) in surface soil/surface sediment samples collected near historical IHSSs.

## 4.14 Radium-228

Radium-228 has concentrations statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if radium-228 should be retained for risk characterization are summarized below.

### 4.14.1 Summary of Process Knowledge

The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDH 1991) and no radium-228 waste was reported to have been generated. It is unlikely that radium-228 is present in soil at RFETS as a result of historical site-related activities.

### 4.14.2 Evaluation of Spatial Trends

***Surface Soil/Surface Sediment***

As shown in Figure A3.4.10, radium-228 concentrations exceed the PRG of 0.111 picocuries per gram (pCi/g) at locations throughout the WBEU. There are no locations where the radium-228 concentration exceeds the background MDC. Thus, it appears that radium-228 concentrations in WBEU surface soil reflect variations in naturally occurring radium-228.

### 4.14.3 Pattern Recognition

***Surface Soil/Surface Sediment***

The probability plot for radium-228 concentrations suggests a single population, which is indicative of background conditions (Figure A3.4.11).

### 4.14.4 Comparison to RFETS Background and Other Background Data Sets

***Surface Soil/Surface Sediment***

Radium-228 concentrations in surface soil/surface sediment samples at the WBEU range from 0.94 to 3.50 pCi/g, with a mean concentration of 2.09 pCi/g and a standard deviation of 0.693 pCi/g. The radium-228 concentrations in the background data set range from 0.200 to 4.10 pCi/g, with a mean concentration of 1.60 pCi/g and a standard deviation of 0.799 pCi/g (Table A3.2.2). The range of concentrations of radium-228 in the WBEU and background samples considerably overlaps and the means are similar. Furthermore, radium-228 detections in WBEU surface soil/surface sediment are all below the background MDC.

### 4.14.5 Risk Potential for HHRA

The radium-228 UCL for surface soil/surface sediment is 2.23 pCi/g. The PRG is 0.111 pCi/g, with all of the detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 2E-05 and is well within the National Contingency Plan risk range of 1E-06 to 1E-04. Because the radium-228 concentrations appear to be naturally occurring, the excess cancer risks to the WRW from exposure to radium-228 in surface soil/surface sediment in the WBEU is similar to background risk.

### 4.14.6 Conclusion

The weight of evidence presented above shows that radium-228 concentrations in WBEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring radium-228; and a probability plot that suggests the presence of a single population, which is also indicative of background conditions. The WBEU radium-228 concentrations are unlikely to result in risks to humans significantly above background risks. Radium-228 is not considered a COC in surface soil/surface sediment in WBEU and, therefore, is not further evaluated quantitatively.

## 4.15 Silver

Silver has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if silver should be retained for risk characterization are summarized below.

### 4.15.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that silver was used in small quantities at the site and waste was generated from both laboratory and process buildings. Based on process knowledge, silver was present in the metals inventory, silver waste at the site and, therefore, silver may be present in RFETS soil as a result of historical site-related activities.

### 4.15.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, WBEU surface soil samples have concentrations of silver greater than the minimum ESL and the background MDC at locations near historical IHSSs. Therefore, based on this line of evidence, silver in surface soil cannot be eliminated as an ECOPC for the WBEU and will be evaluated in the risk characterization.

### 4.15.3 Conclusion

The weight of evidence presented above shows that silver concentrations in WBEU surface soil (non-PMJM) may be a result of historical site-related activities based on process knowledge. However, the spatial distribution analysis indicates that elevated silver concentrations within the WBEU are located near historical IHSSs. Therefore, based on this line of evidence, silver in surface soil is considered an ECOPC and is evaluated in the risk characterization.

## 4.16 Thallium

For thallium in surface soil, a statistical comparison between WBEU and RFETS background data could not be performed because thallium was not detected in RFETS background surface soil samples. Thallium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if thallium should be retained for risk characterization are summarized below.

### 4.16.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that thallium was used in small quantities at the site, thallium waste was generated from both laboratory and process buildings, and thallium compounds were identified in the ChemRisk reports but were not carried forward as a material of concern (CDH 1991). Based on process knowledge, thallium is not likely to be present at WBEU soil as a result of historical site-related activities.

### 4.16.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, thallium in surface soil cannot be eliminated as an ECOPC for the WBEU and, as a conservative measure, is evaluated in the risk characterization because concentrations above background were located near historical IHSSs.

### 4.16.3 Conclusion

The weight of evidence presented above shows that thallium concentrations in WBEU surface soil (non-PMJM) are not likely to be a result of historical site-related activities based on process knowledge. However, the spatial distribution analysis indicates that elevated thallium concentrations within the WBEU are located near historical IHSSs. Therefore, based on this line of evidence, thallium in surface soil is considered an ECOPC and is evaluated in the risk characterization.

## 4.17 Tin

For tin in surface soil, a statistical comparison between WBEU and RFETS background data could not be performed because tin was not detected in RFETS background surface soil samples. Tin has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if tin should be retained for risk characterization are summarized below.

### 4.17.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, tin was present in the metals inventory and may be present in RFETS soil as a result of historical site-related activities.

#### 4.17.2 Evaluation of Spatial Trends

***Surface Soil (Non-PMJM)***

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the MDC and EPC for tin exceed the minimum ESL in surface soil locations within WBEU. Therefore, based on this line of evidence, tin in surface soil cannot be eliminated as an ECOPC for the WBEU and is carried into the risk characterization.

#### 4.17.3 Conclusion

The weight of evidence presented above shows that tin concentrations in WBEU surface soil (non-PMJM) may be a result of historical site-related activities based on process knowledge. The spatial distribution analysis indicates that elevated tin concentrations are located within the WBEU. Therefore, based on this line of evidence, tin in surface soil is considered an ECOPC and is evaluated in the risk characterization.

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# TABLES

**Table A3.2.1**
**Statistical Distribution and Comparison to Background for WBEU Surface Soil/Surface Sediment**

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Result | | |
|---|---|---|---|---|---|---|---|---|---|
| | Background Data Set | | | WBEU Data Set (excluding background samples) | | | Test | 1 - p | Statistically Greater than Background? |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| **Arsenic** | **73** | **GAMMA** | **92** | **160** | **GAMMA** | **100** | **WRS** | **2.36E-08** | **Yes** |
| Cesium-137 | 105 | NON-PARAMETRIC | 100 | 37 | NON-PARAMETRIC | 100 | WRS | 0.206 | No |
| **Plutonium-239/240** | **94** | **NON-PARAMETRIC** | **100** | **319** | **NON-PARAMETRIC** | **100** | **WRS** | **0** | **Yes** |
| **Radium-228** | **40** | **GAMMA** | **100** | **17** | **NORMAL** | **100** | **WRS** | **0.00727** | **Yes** |

WRS = Wilcoxon Rank Sum.
**Bold = Analyte retained for further consideration in the next COC selection step.**

**Table A3.2.2**
**Summary Statistics for Background and WBEU Surface Soil/Surface Sediment [a]**

| Analyte | Units | Background | | | | | WBEU (excluding background samples) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation |
| Arsenic | mg/kg | 73 | 0.270 | 9.60 | 3.42 | 2.55 | 160 | 1.00 | 11.0 | 5.20 | 2.12 |
| Cesium-137 | pCi/g | 105 | -0.027 | 1.80 | 0.692 | 0.492 | 37 | 0.050 | 2.01 | 0.781 | 0.565 |
| Plutonium-239/240 | pCi/g | 94 | -0.010 | 0.350 | 0.032 | 0.039 | 319 | -0.003 | 49.0 | 9.19 | 12.0 |
| Radium-228 | pCi/g | 40 | 0.200 | 4.10 | 1.60 | 0.799 | 17 | 0.940 | 3.50 | 2.09 | 0.693 |

[a] Statistics are computed using one-half of the report values for nondetects.

**Table A3.2.3**
**Statistical Distribution and Comparison to Background for WBEU Subsurface Soil/Subsurface Sediment**

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | Background Data Set | | | WBEU Data Set (excluding background samples) | | | Test | 1 - p | Statistically Greater than Background? |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| Radium-228 | 31 | GAMMA | 100 | 65 | NORMAL | 100 | WRS | 0.973 | No |

WRS = Wilcoxon Rank Sum.

**Table A3.2.4**
**Summary Statistics for Background and WBEU Suburface Soil/Subsurface Sediment[a]**

| Analyte | Units | Background Data Set | | | | | WBEU Data Set (excluding background samples) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation |
| Radium-228 | pCi/g | 31 | 1.00 | 2.10 | 1.45 | 0.320 | 65 | 0 | 2.60 | 1.25 | 0.513 |

[a] Statistics are computed using one-half of the report values for nondetects.

**Table A3.2.5**
**Statistical Distribution and Comparison to Background for WBEU Surface Soil**

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | Background Data Set | | | WBEU Data Set (excluding background samples) | | | Test | 1 - p | Statistically Greater than Background? |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| **Aluminum** | **20** | **NORMAL** | **100** | **151** | **GAMMA** | **100** | **WRS** | **0.00263** | **Yes** |
| Arsenic | 20 | NORMAL | 100 | 151 | GAMMA | 100 | WRS | 0.961 | No |
| **Barium** | **20** | **NORMAL** | **100** | **151** | **NON-PARAMETRIC** | **100** | **WRS** | **5.22E-05** | **Yes** |
| **Boron** | **N/A** | **N/A** | **N/A** | **76** | **NON-PARAMETRIC** | **93** | **N/A** | **N/A** | **N/A** |
| Cadmium | 20 | NON-PARAMETRIC | 65 | 150 | NON-PARAMETRIC | 45 | WRS | 0.991 | No |
| **Chromium** | **20** | **NORMAL** | **100** | **151** | **NON-PARAMETRIC** | **100** | **WRS** | **0.00141** | **Yes** |
| Cobalt | 20 | NORMAL | 100 | 151 | NORMAL | 100 | t-Test_N | 0.879 | No |
| Copper | 20 | NON-PARAMETRIC | 100 | 150 | NON-PARAMETRIC | 100 | WRS | 0.159 | No |
| Lead | 20 | NORMAL | 100 | 151 | NON-PARAMETRIC | 100 | WRS | 0.610 | No |
| **Lithium** | **20** | **NORMAL** | **100** | **131** | **GAMMA** | **92** | **WRS** | **1.55E-04** | **Yes** |
| **Manganese** | **20** | **NORMAL** | **100** | **151** | **NON-PARAMETRIC** | **100** | **WRS** | **0.0911** | **Yes** |
| Mercury | 20 | NON-PARAMETRIC | 40 | 132 | NON-PARAMETRIC | 52 | WRS | 1.000 | No |
| **Molybdenum** | **20** | **NORMAL** | **0** | **137** | **NON-PARAMETRIC** | **28** | **N/A** | **N/A** | **N/A** |
| **Nickel** | **20** | **NORMAL** | **100** | **151** | **LOGNORMAL** | **97** | **WRS** | **1.31E-04** | **Yes** |
| **Silver** | **20** | **NORMAL** | **0** | **142** | **NON-PARAMETRIC** | **25** | **N/A** | **N/A** | **N/A** |
| **Thallium** | **14** | **NORMAL** | **0** | **151** | **NON-PARAMETRIC** | **21** | **N/A** | **N/A** | **N/A** |
| **Tin** | **20** | **NORMAL** | **0** | **137** | **NON-PARAMETRIC** | **15** | **N/A** | **N/A** | **N/A** |
| **Uranium** | **N/A** | **N/A** | **N/A** | **76** | **NON-PARAMETRIC** | **5** | **N/A** | **N/A** | **N/A** |
| Vanadium | 20 | NORMAL | 100 | 151 | LOGNORMAL | 100 | WRS | 0.161 | No |
| Zinc | 20 | NORMAL | 100 | 151 | NON-PARAMETRIC | 100 | WRS | 0.420 | No |

WRS = Wilcoxon Rank Sum.

t-Test_N = Student's t-test using normal data.

N/A = not applicable; site and/or background detection frequency less than 20%.

**Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.**

**Table A3.2.6**
**Summary Statistics For Background and WBEU Surface Soil[a]**

| Analyte | Units | Background | | | | | WBEU (excluding background samples) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation |
| Aluminum | mg/kg | 20 | 4,050 | 17,100 | 10,203 | 3,256 | 151 | 4,780 | 33,000 | 14,613 | 6,893 |
| Arsenic | mg/kg | 20 | 2.30 | 9.60 | 6.09 | 2.00 | 151 | 1.00 | 11.0 | 5.21 | 2.14 |
| Barium | mg/kg | 20 | 45.7 | 134 | 102 | 19.4 | 151 | 34.9 | 280 | 135 | 47.3 |
| Boron | mg/kg | N/A | N/A | N/A | N/A | N/A | 76 | 0.670 | 15.0 | 6.82 | 3.63 |
| Cadmium | mg/kg | 20 | 0.670 | 2.30 | 0.708 | 0.455 | 150 | 0.065 | 2.60 | 0.496 | 0.351 |
| Chromium | mg/kg | 20 | 5.50 | 16.9 | 11.2 | 2.78 | 151 | 2.20 | 80.5 | 16.5 | 10.3 |
| Cobalt | mg/kg | 20 | 3.40 | 11.2 | 7.27 | 1.79 | 151 | 2.20 | 21.6 | 6.61 | 2.42 |
| Copper | mg/kg | 20 | 5.20 | 16.0 | 13.0 | 2.58 | 150 | 2.20 | 49.8 | 14.8 | 6.15 |
| Lead | mg/kg | 20 | 8.60 | 53.3 | 33.5 | 10.5 | 151 | 3.00 | 120 | 34.4 | 20.5 |
| Lithium | mg/kg | 20 | 4.80 | 11.6 | 7.66 | 1.89 | 131 | 4.40 | 33.0 | 12.4 | 6.26 |
| Manganese | mg/kg | 20 | 129 | 357 | 237 | 63.9 | 151 | 54.0 | 1,200 | 284 | 147 |
| Mercury | mg/kg | 20 | 0.090 | 0.120 | 0.072 | 0.031 | 132 | 0.006 | 0.250 | 0.045 | 0.036 |
| Molybdenum | mg/kg | 20 | ND | ND | 0.573 | 0.184 | 137 | 0.150 | 3.00 | 1.07 | 1.00 |
| Nickel | mg/kg | 20 | 3.80 | 14.0 | 9.60 | 2.59 | 151 | 4.40 | 101 | 14.6 | 10.3 |
| Silver | mg/kg | 20 | ND | ND | 0.207 | 0.007 | 142 | 0.081 | 42.8 | 1.30 | 4.22 |
| Thallium | mg/kg | 14 | ND | ND | 0.414 | 0.015 | 151 | 0.210 | 3.30 | 0.417 | 0.414 |
| Tin | mg/kg | 20 | ND | ND | 2.06 | 0.410 | 137 | 1.30 | 75.8 | 7.95 | 11.3 |
| Uranium | mg/kg | N/A | N/A | N/A | N/A | N/A | 76 | 1.90 | 8.00 | 1.89 | 1.41 |
| Vanadium | mg/kg | 20 | 10.8 | 45.8 | 27.7 | 7.68 | 151 | 12.1 | 72.0 | 31.9 | 12.2 |
| Zinc | mg/kg | 20 | 21.1 | 75.9 | 49.8 | 12.2 | 151 | 15.0 | 165 | 51.3 | 18.6 |
| Benzo(a)pyrene | ug/kg | N/A | N/A | N/A | N/A | N/A | 85 | 48.0 | 750 | 207 | 92.4 |
| bis(2-ethylhexyl)phthalate | ug/kg | N/A | N/A | N/A | N/A | N/A | 85 | 56.0 | 510 | 209 | 83.5 |
| Endrin | ug/kg | N/A | N/A | N/A | N/A | N/A | 40 | 4.50 | 5.10 | 8.87 | 1.51 |
| Total PCBs | ug/kg | N/A | N/A | N/A | N/A | N/A | 81 | 20.1 | 3,365 | 184 | 382 |

[a] Statistics are computed using one-half of the report values for nondetects.

**Table A3.2.7**
**Statistical Distribution and Comparison to Background for WBEU Subsurface Soil**

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | Background Data Set | | | WBEU Data Set (excluding background samples) | | | Test | 1 - p | Statistically Greater than Background? |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| **Antimony** | **28** | **NON-PARAMETRIC** | **7.14** | **303** | **NON-PARAMETRIC** | **15.2** | **N/A** | **N/A** | **N/A** |
| Arsenic | 45 | NON-PARAMETRIC | 93.3 | 309 | GAMMA | 98.1 | WRS | 0.280 | No |
| Chromium | 45 | GAMMA | 100 | 309 | NON-PARAMETRIC | 100 | WRS | 0.859 | No |
| Lead | 45 | GAMMA | 100 | 309 | NON-PARAMETRIC | 99.7 | WRS | 1.000 | No |
| Mercury | 41 | NON-PARAMETRIC | 29.3 | 308 | NON-PARAMETRIC | 63.6 | WRS | 1.000 | No |
| Molybdenum | 45 | NON-PARAMETRIC | 66.7 | 304 | NON-PARAMETRIC | 50 | WRS | 1.00 | No |
| Nickel | 44 | GAMMA | 100 | 309 | NON-PARAMETRIC | 98.7 | WRS | 0.995 | No |
| Tin | 41 | NON-PARAMETRIC | 36.6 | 303 | NON-PARAMETRIC | 24.8 | WRS | 1.000 | No |

WRS = Wilcoxon Rank Sum.
**Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.**

**Tablle A3.2.8**

**Summary Statistics for Background and WBEU Subsurface Soil[a]**

| Analyte | Units | Background | | | | | WBEU (excluding background samples) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation |
| Antimony | mg/kg | 28 | 2.90 | 8.20 | 4.21 | 2.78 | 303 | 0.300 | 350 | 4.60 | 25.5 |
| Arsenic | mg/kg | 45 | 1.70 | 41.8 | 5.48 | 6.02 | 309 | 0.820 | 25.9 | 5.21 | 3.13 |
| Chromium | mg/kg | 45 | 5.80 | 69.6 | 18.4 | 11.9 | 309 | 2.90 | 4,600 | 32.7 | 261 |
| Lead | mg/kg | 45 | 4.20 | 25.8 | 13.9 | 6.31 | 309 | 1.50 | 8,500 | 42.9 | 484 |
| Mercury | mg/kg | 41 | 0.190 | 0.640 | 0.155 | 0.166 | 308 | 0.002 | 3.40 | 0.097 | 0.345 |
| Molybdenum | mg/kg | 45 | 3.50 | 41.0 | 13.5 | 7.80 | 304 | 0.140 | 1,970 | 7.97 | 113 |
| Nickel | mg/kg | 44 | 4.30 | 54.2 | 20.9 | 11.1 | 309 | 2.70 | 1,330 | 24.1 | 80.6 |
| Tin | mg/kg | 41 | 25.7 | 441 | 86.0 | 134 | 303 | 0.570 | 110 | 7.02 | 11.7 |

[a] Statistics are computed using one-half of the report values for nondetects.

**Table A3.4.1**
**Summary of Element Concentrations in Colorado and Bordering States Surface Soil [a]**

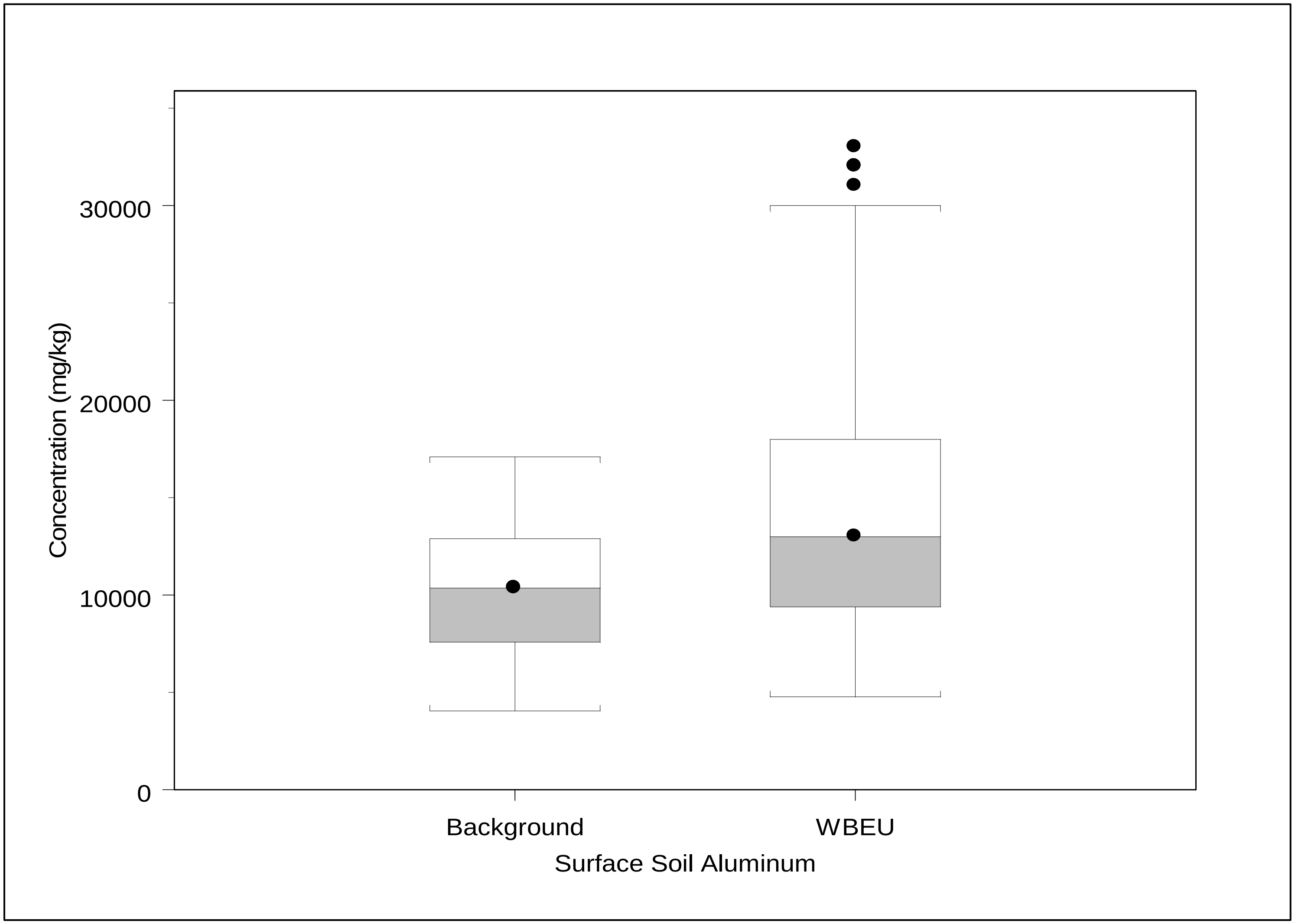
| Analyte | Total Number of Results | Detection Frequency (%) | Range of Detected Values (mg/kg) | Average (mg/kg)[b] | Standard Deviation (mg/kg)[b] |
|---|---|---|---|---|---|
| Aluminum | 303 | 100 | 5,000 - 100,000 | 50,800 | 23,500 |
| Antimony | 84 | 15.5 | 1.038 - 2.531 | 0.647 | 0.378 |
| Arsenic | 307 | 99.3 | 1.224 - 97 | 6.9 | 7.64 |
| Barium | 342 | 100 | 100 - 3,000 | 642 | 330 |
| Beryllium | 342 | 36 | 1 - 7 | 0.991 | 0.876 |
| Boron | 342 | 66.7 | 20 - 150 | 27.9 | 19.7 |
| Bromine | 85 | 50.6 | 0.5038 - 3.522 | 0.681 | 0.599 |
| Calcium | 342 | 100 | 0.055 - 32 | 3.09 | 4.13 |
| Carbon | 85 | 100 | 0.3 - 10 | 2.18 | 1.92 |
| Cerium | 291 | 16.2 | 150 - 300 | 90 | 38.4 |
| Chromium | 342 | 100 | 3 - 500 | 48.2 | 41 |
| Cobalt | 342 | 88.6 | 3 - 30 | 8.09 | 5.03 |
| Copper | 342 | 100 | 2 - 200 | 23.1 | 17.7 |
| Fluorine | 264 | 97.3 | 10 - 1,900 | 394 | 261 |
| Gallium | 340 | 99.1 | 5 - 50 | 18.3 | 8.9 |
| Germanium | 85 | 100 | 0.5777 - 2.146 | 1.18 | 0.316 |
| Iodine | 85 | 78.8 | 0.516 - 3.487 | 1.07 | 0.708 |
| Iron | 342 | 100 | 3,000 - 100,000 | 21,100 | 13,500 |
| Lanthanum | 341 | 66.3 | 30 - 200 | 39.8 | 28.8 |
| Lead | 342 | 92.7 | 10 - 700 | 24.8 | 41.5 |
| Lithium | 307 | 100 | 5 - 130 | 25.3 | 14.4 |
| Magnesium | 341 | 100 | 300 - 50,000 | 8,630 | 6,400 |
| Manganese | 342 | 100 | 70 - 2,000 | 414 | 272 |
| Mercury | 309 | 99 | 0.01 - 4.6 | 0.0768 | 0.276 |
| Molybdenum | 340 | 3.53 | 3 - 7 | 1.59 | 0.522 |
| Neodymium | 256 | 22.7 | 70 - 300 | 47.1 | 31.7 |
| Nickel | 342 | 96.5 | 5 - 700 | 18.8 | 39.8 |
| Niobium | 335 | 63.3 | 10 - 100 | 11.4 | 8.68 |
| Phosphorus | 249 | 100 | 40 - 4,497 | 399 | 397 |
| Potassium | 341 | 100 | 1,900 - 63,000 | 18,900 | 6,980 |
| Rubidium | 85 | 100 | 35 - 140 | 75.8 | 25 |
| Scandium | 342 | 85.1 | 5 - 30 | 8.64 | 4.69 |
| Selenium | 309 | 80.6 | 0.1023 - 4.3183 | 0.349 | 0.415 |
| Silicon | 85 | 100 | 149,340 - 413,260 | 302,000 | 61,500 |
| Sodium | 335 | 100 | 500 - 70,000 | 10,400 | 6,260 |
| Strontium | 342 | 100 | 10 - 2,000 | 243 | 212 |
| Sulfur | 85 | 16.5 | 816 - 47,760 | 1,250 | 5,300 |
| Thallium | 76 | 100 | 2.45 - 20.79 | 9.71 | 3.54 |
| Tin | 85 | 96.5 | 0.117 - 5.001 | 1.15 | 0.772 |
| Titanium | 342 | 100 | 500 - 7,000 | 2,290 | 1,350 |
| Uranium | 85 | 100 | 1.11 - 5.98 | 2.87 | 0.883 |
| Vanadium | 342 | 100 | 7 - 300 | 73 | 41.7 |
| Ytterbium | 330 | 99.1 | 1 - 20 | 3.33 | 2.06 |
| Yttrium | 342 | 98 | 10 - 150 | 26.9 | 18.1 |
| Zinc | 330 | 100 | 10 - 2,080 | 72.4 | 159 |
| Zirconium | 342 | 100 | 30 - 1,500 | 220 | 157 |

[a] Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.

[b] One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

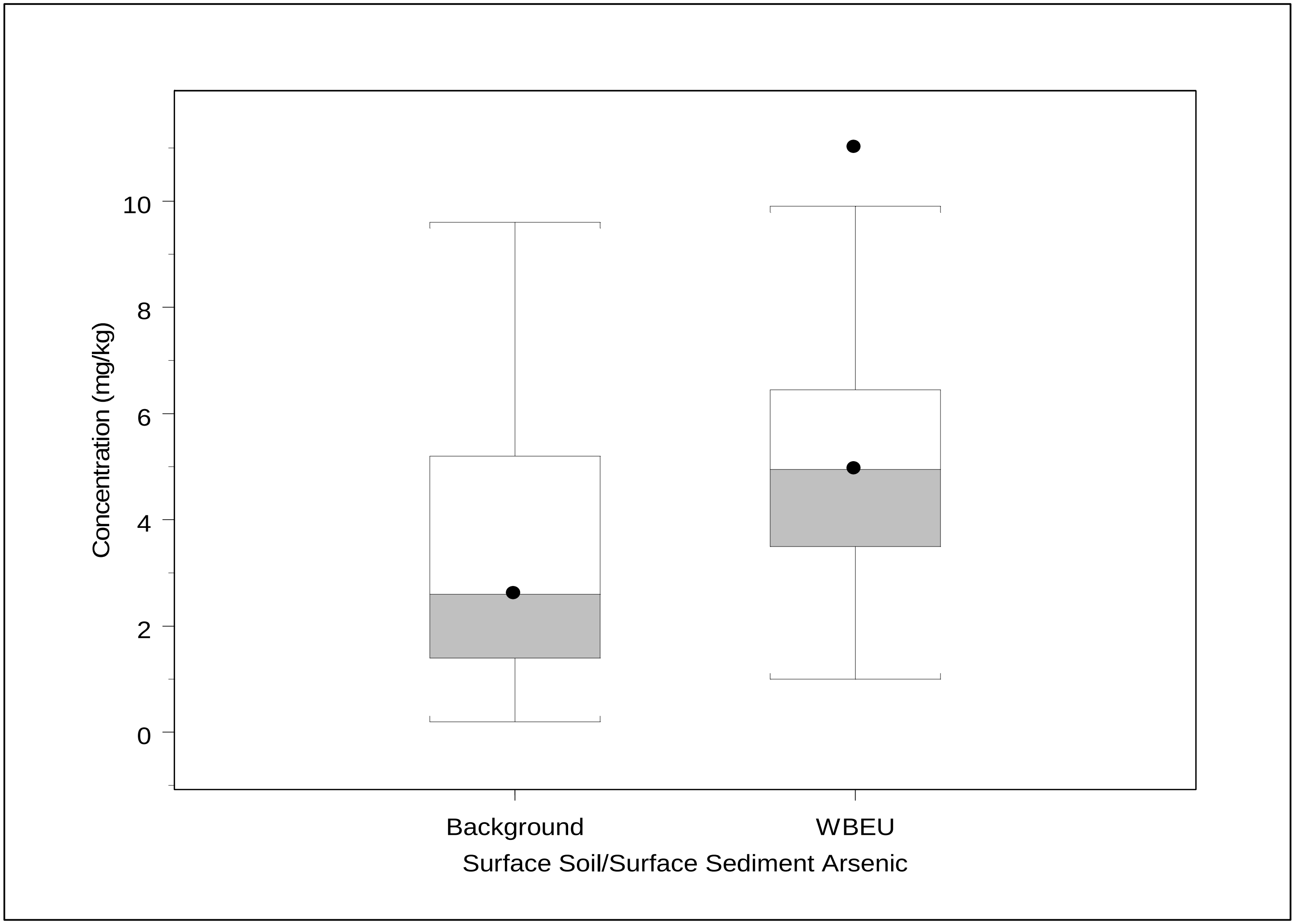
# FIGURES

**Figure A3.2.1**
**WBEU Surface Soil Box Plots for Aluminum**



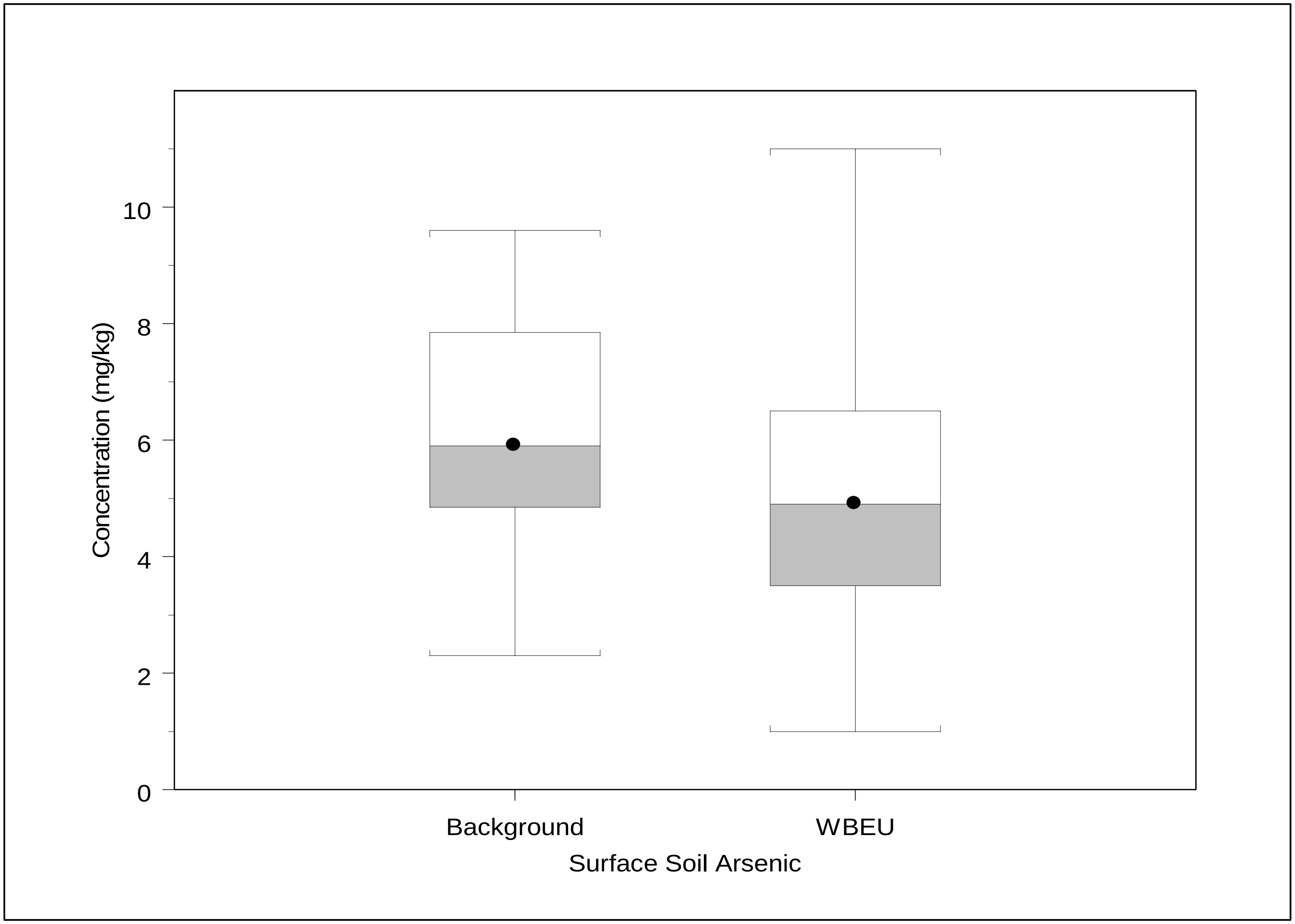

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.2**
**WBEU Surface Soil/Surface Sediment Box Plots for Arsenic**



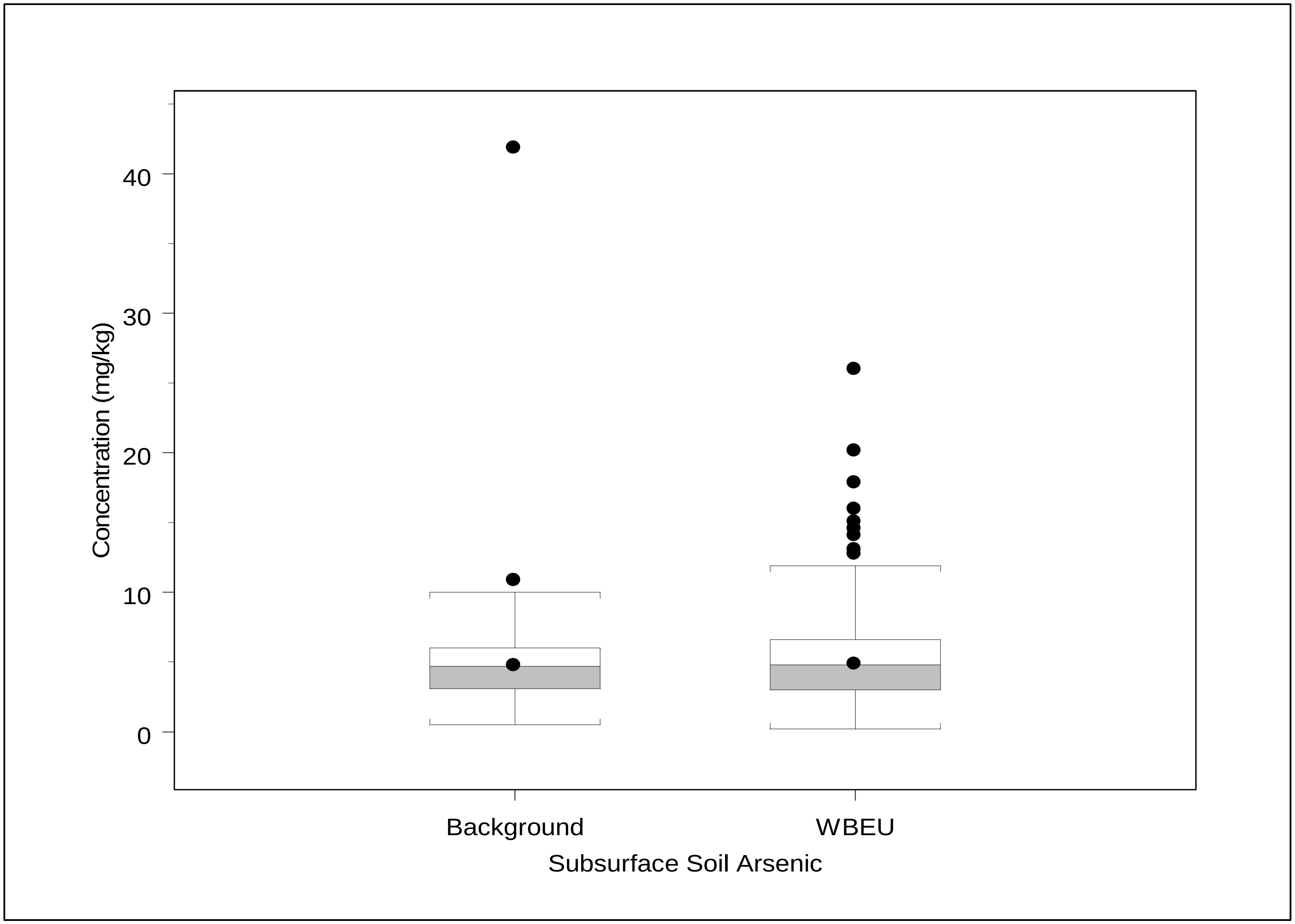

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.3**
**WBEU Surface Soil Box Plots for Arsenic**



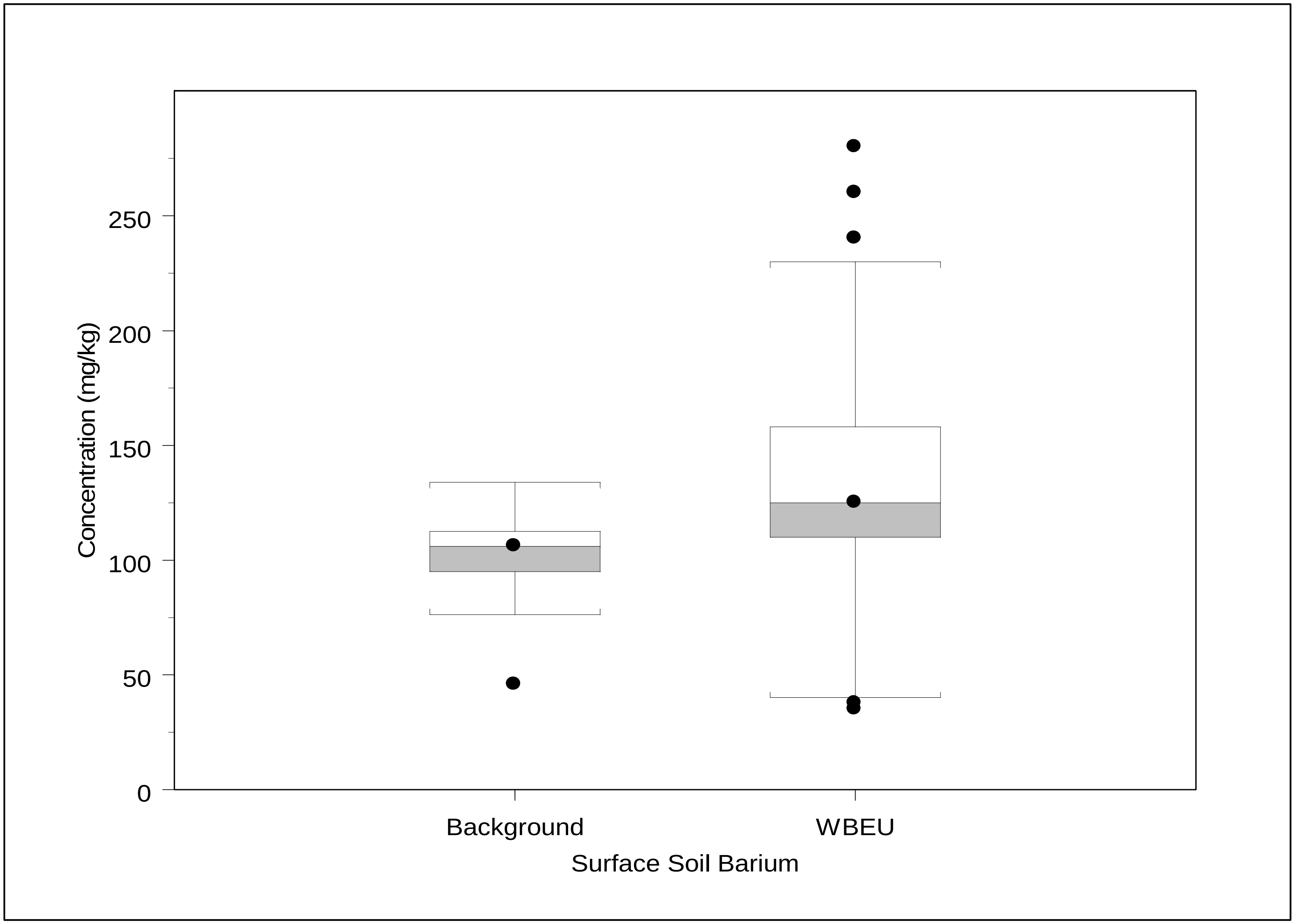

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.4**
**WBEU Subsurface Soil Box Plots for Arsenic**



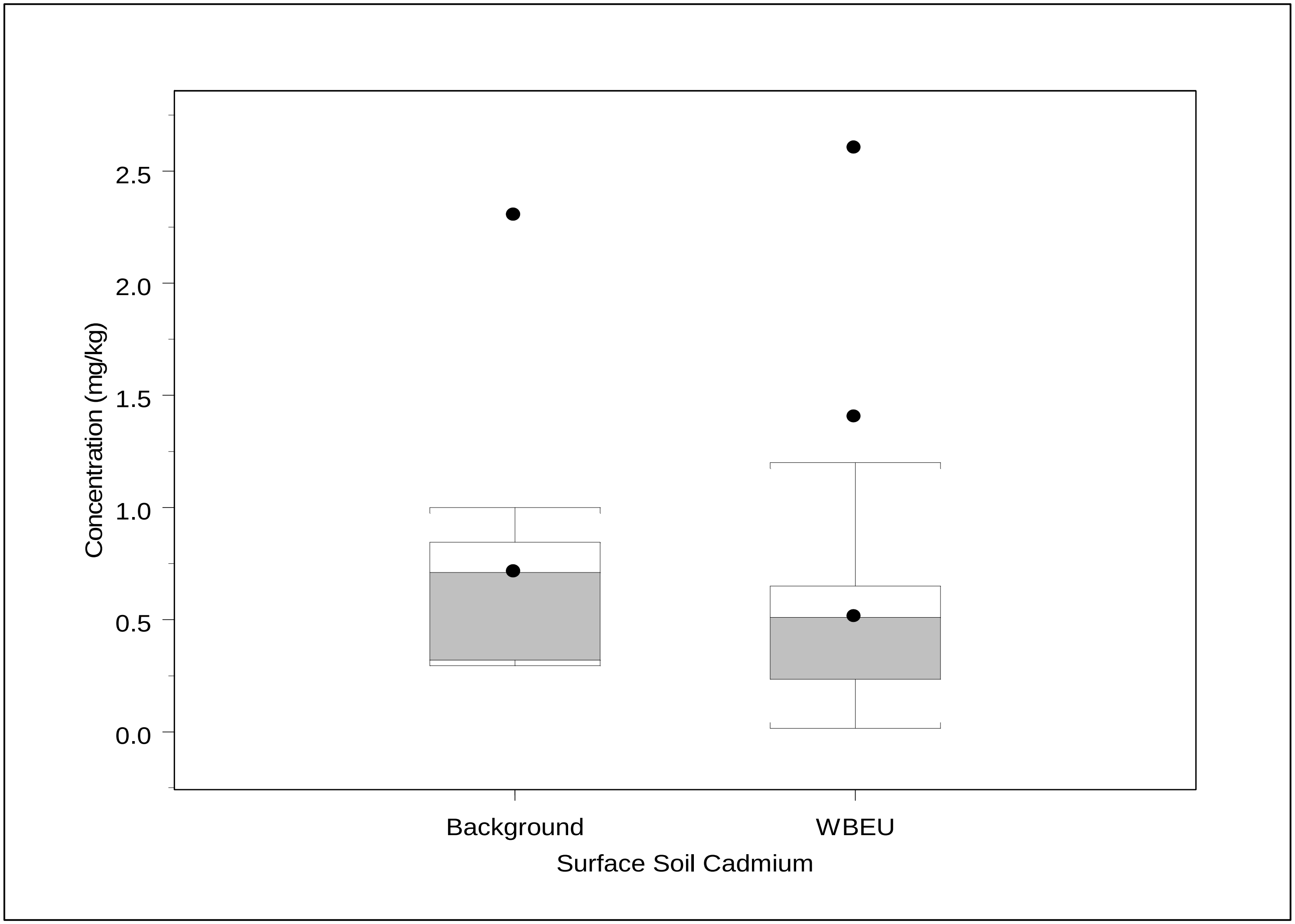

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.5**
**WBEU Surface Soil Box Plots for Barium**



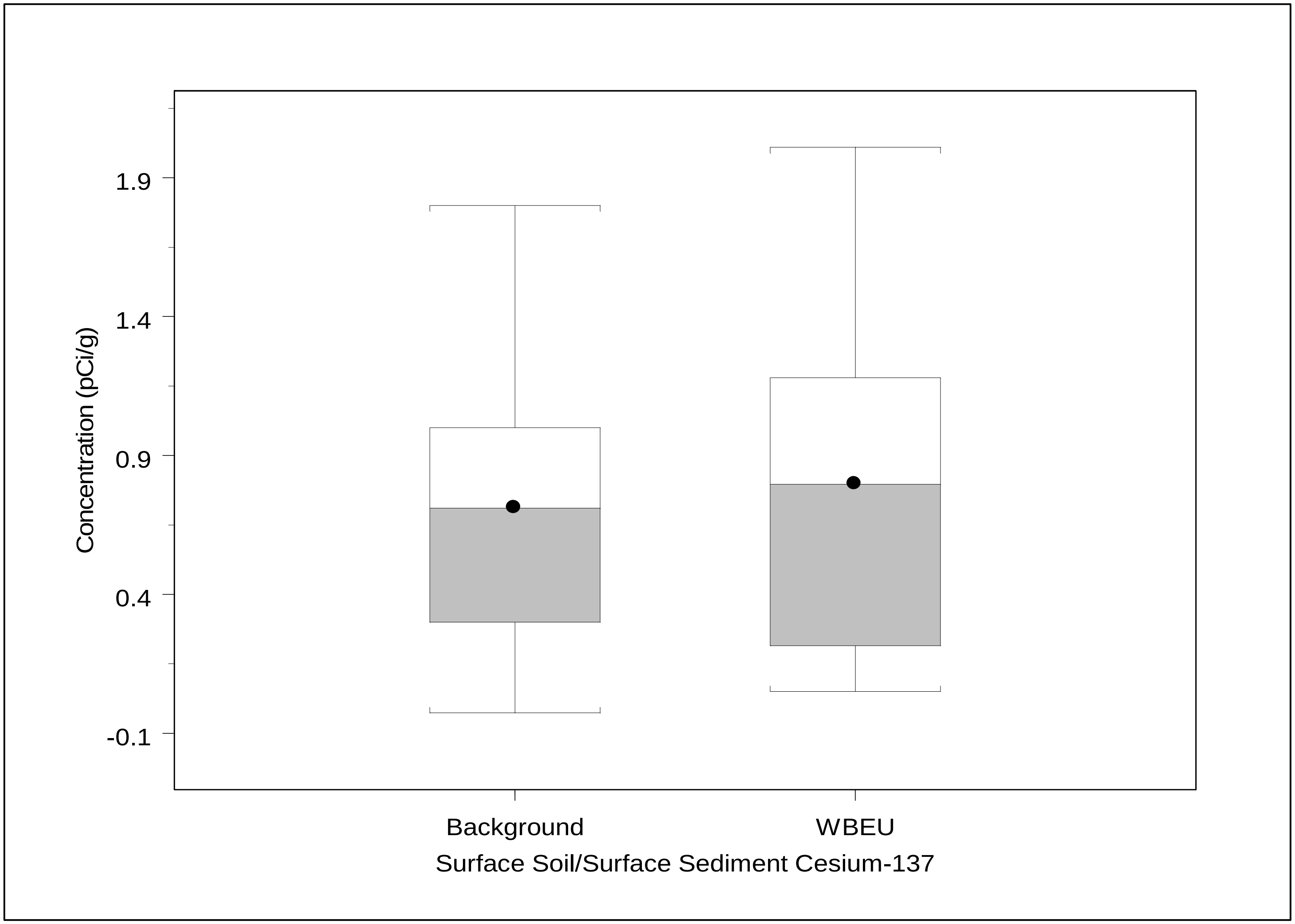

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.6**
**WBEU Surface Soil Box Plots for Cadmium**



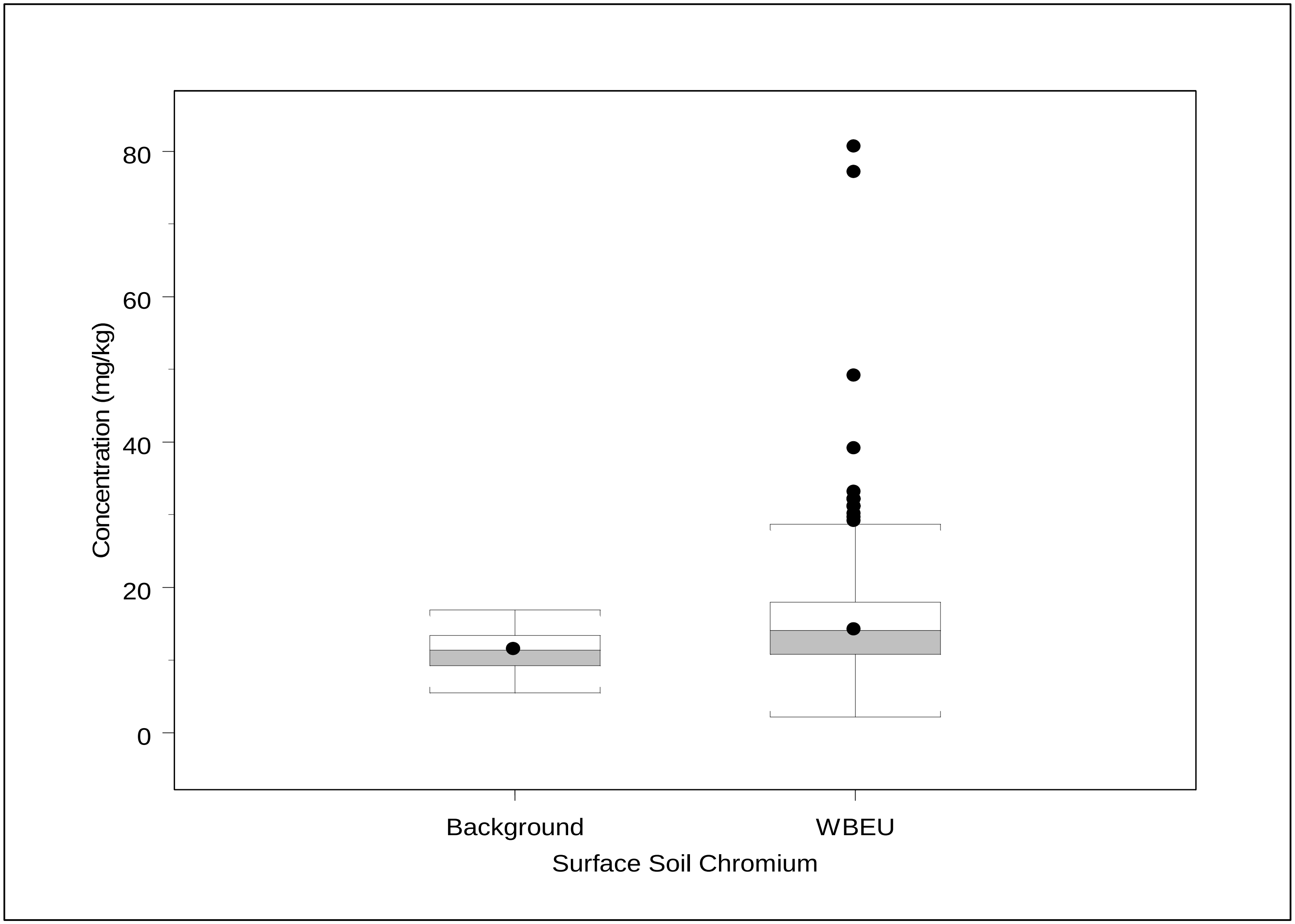

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.7**
**WBEU Surface Soil/Surface Sediment Box Plots for Cesium-137**



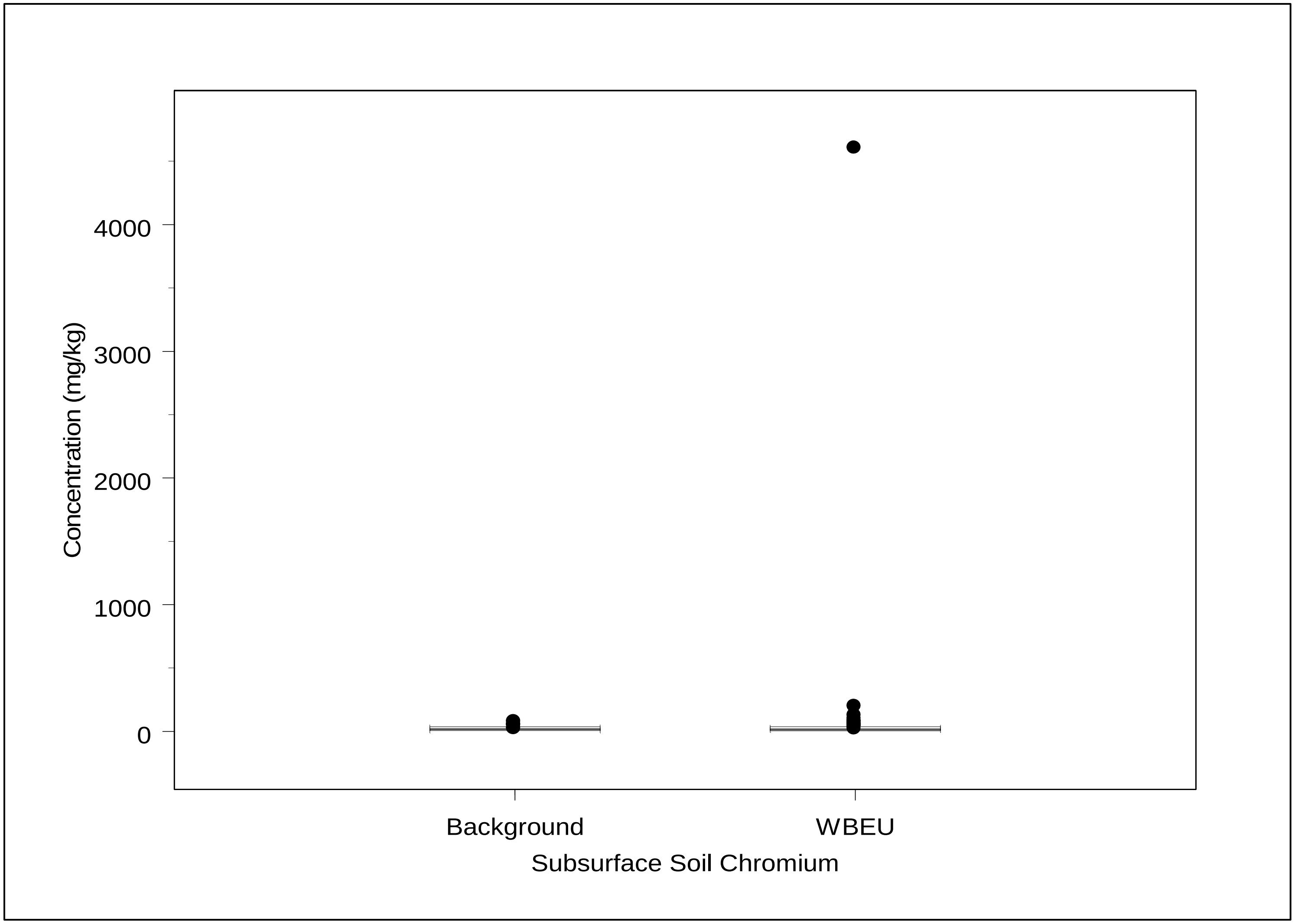

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.8**
**WBEU Surface Soil Box Plots for Chromium**



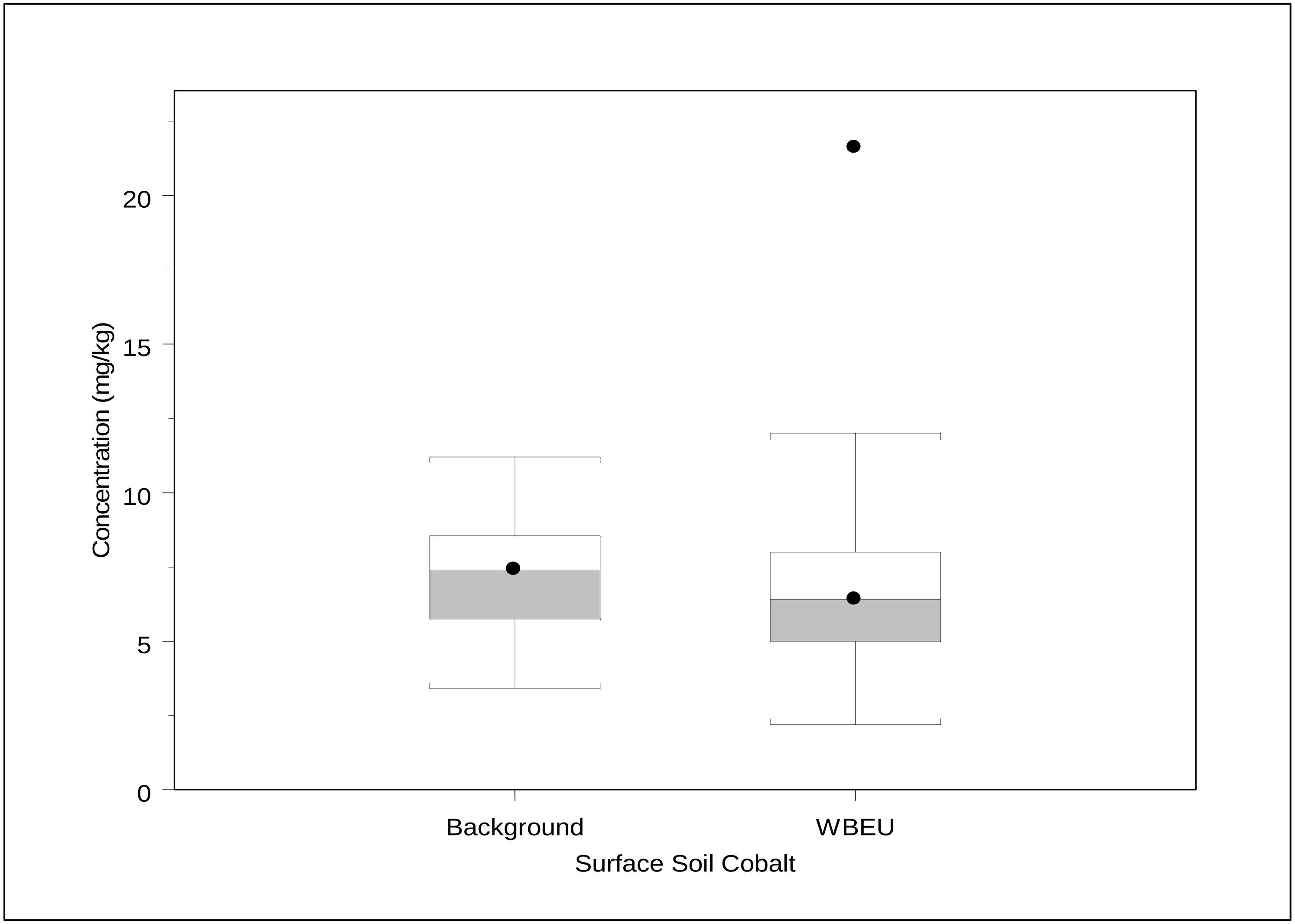

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.9**
**WBEU Subsurface Soil Box Plots for Chromium**



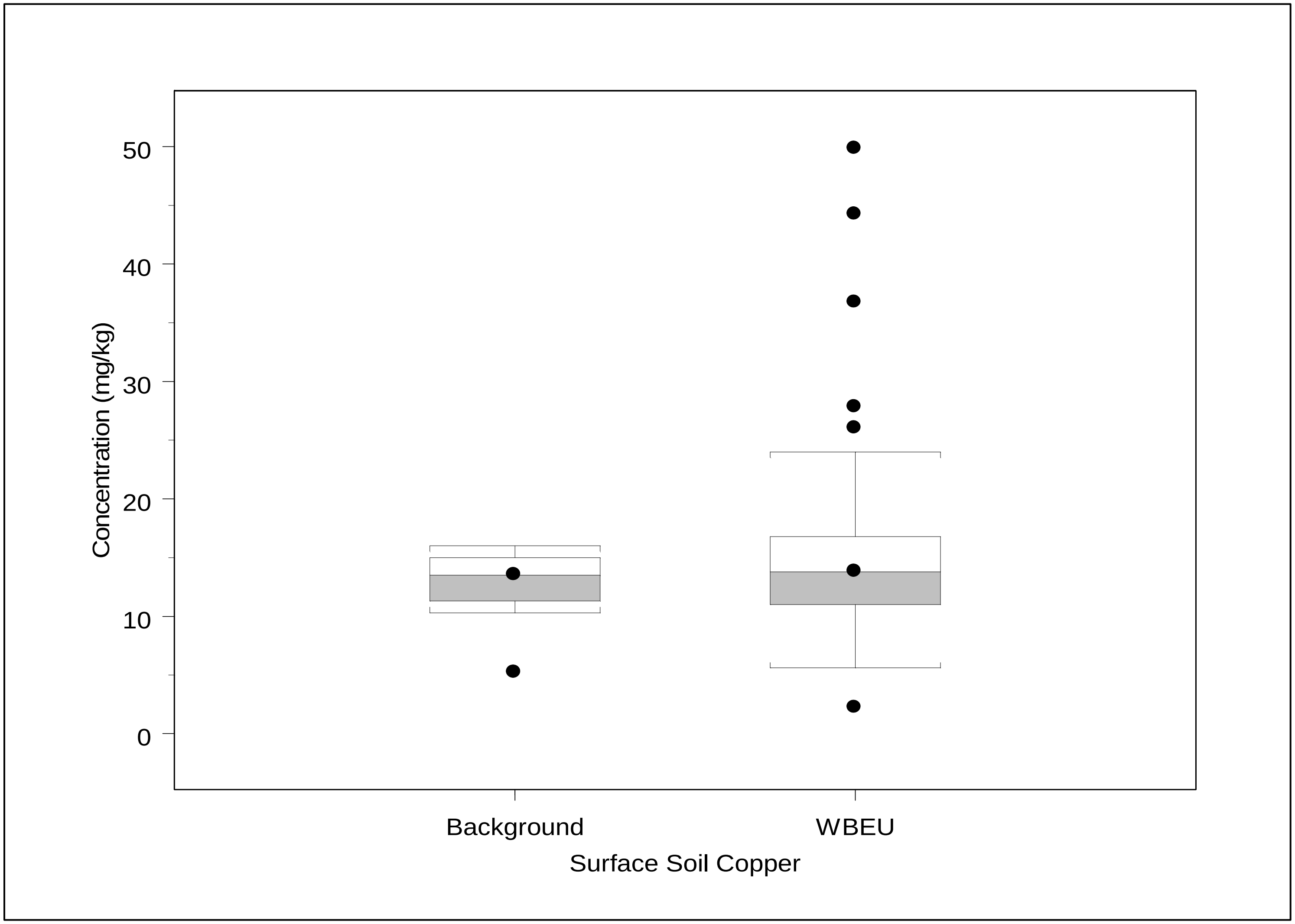

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.10**
**WBEU Surface Soil Box Plots for Cobalt**



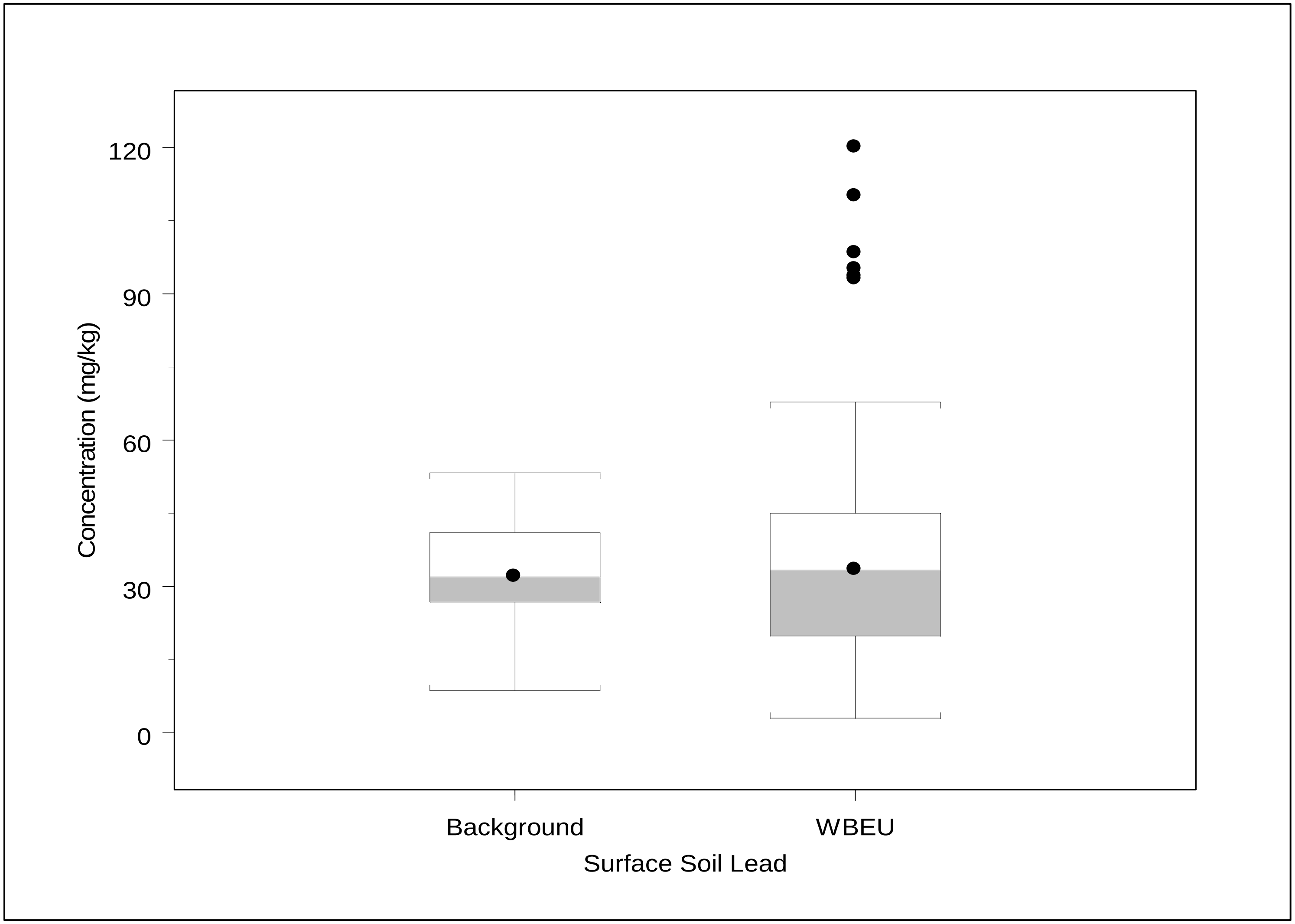

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.11**
**WBEU Surface Soil Box Plots for Copper**



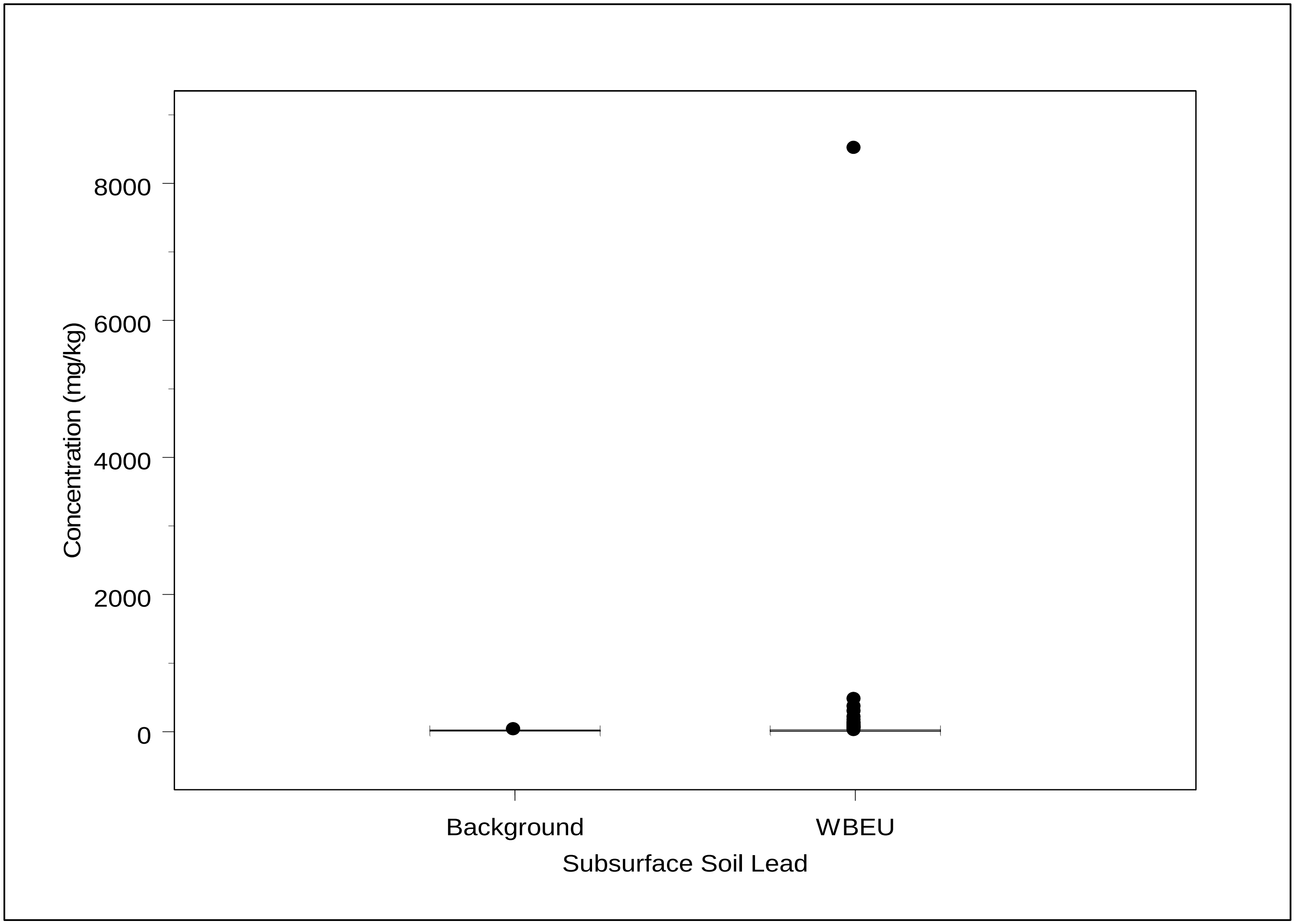

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.12**
**WBEU Surface Soil Box Plots for Lead**



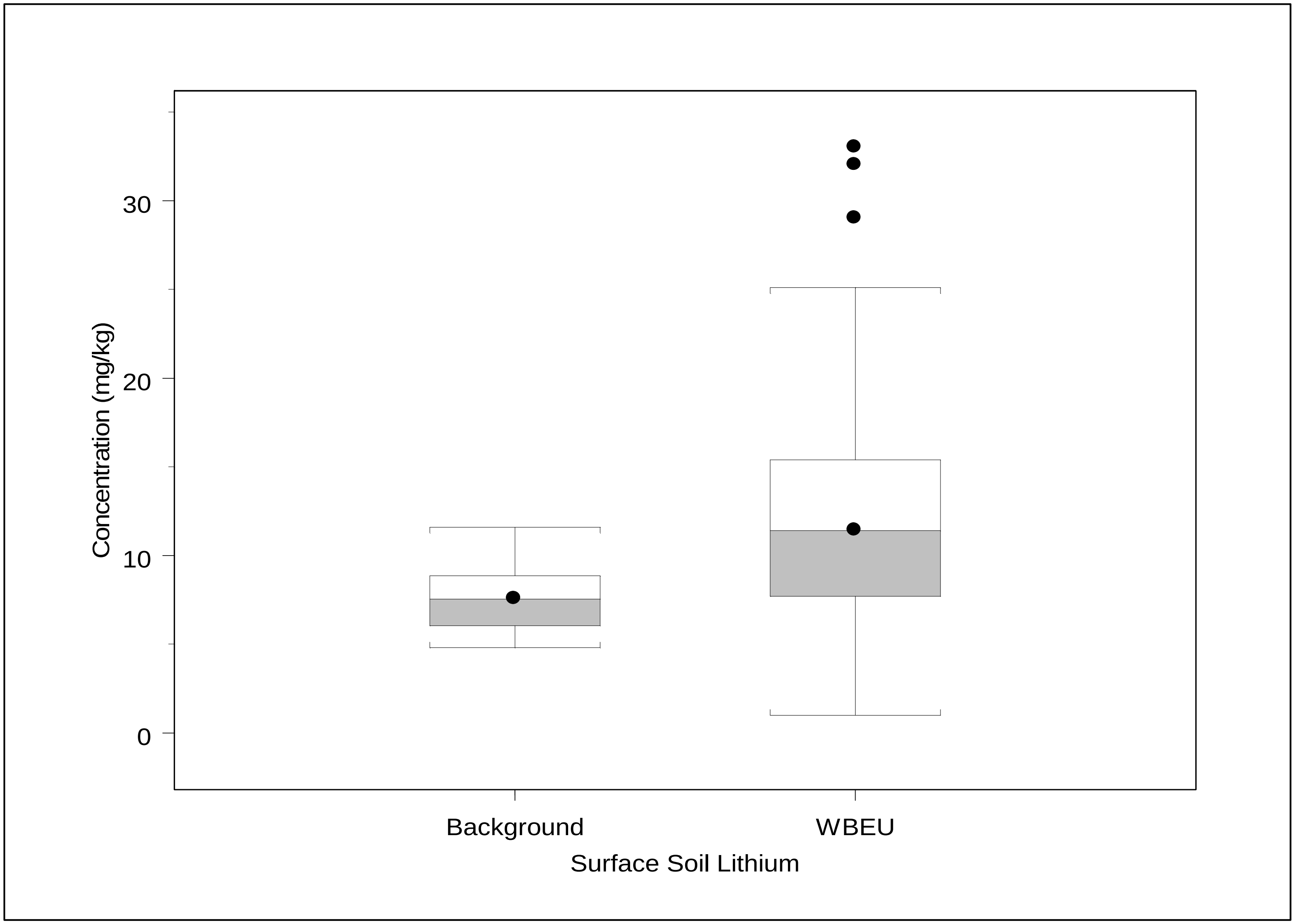

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.13**
**WBEU Subsurface Soil Box Plots for Lead**



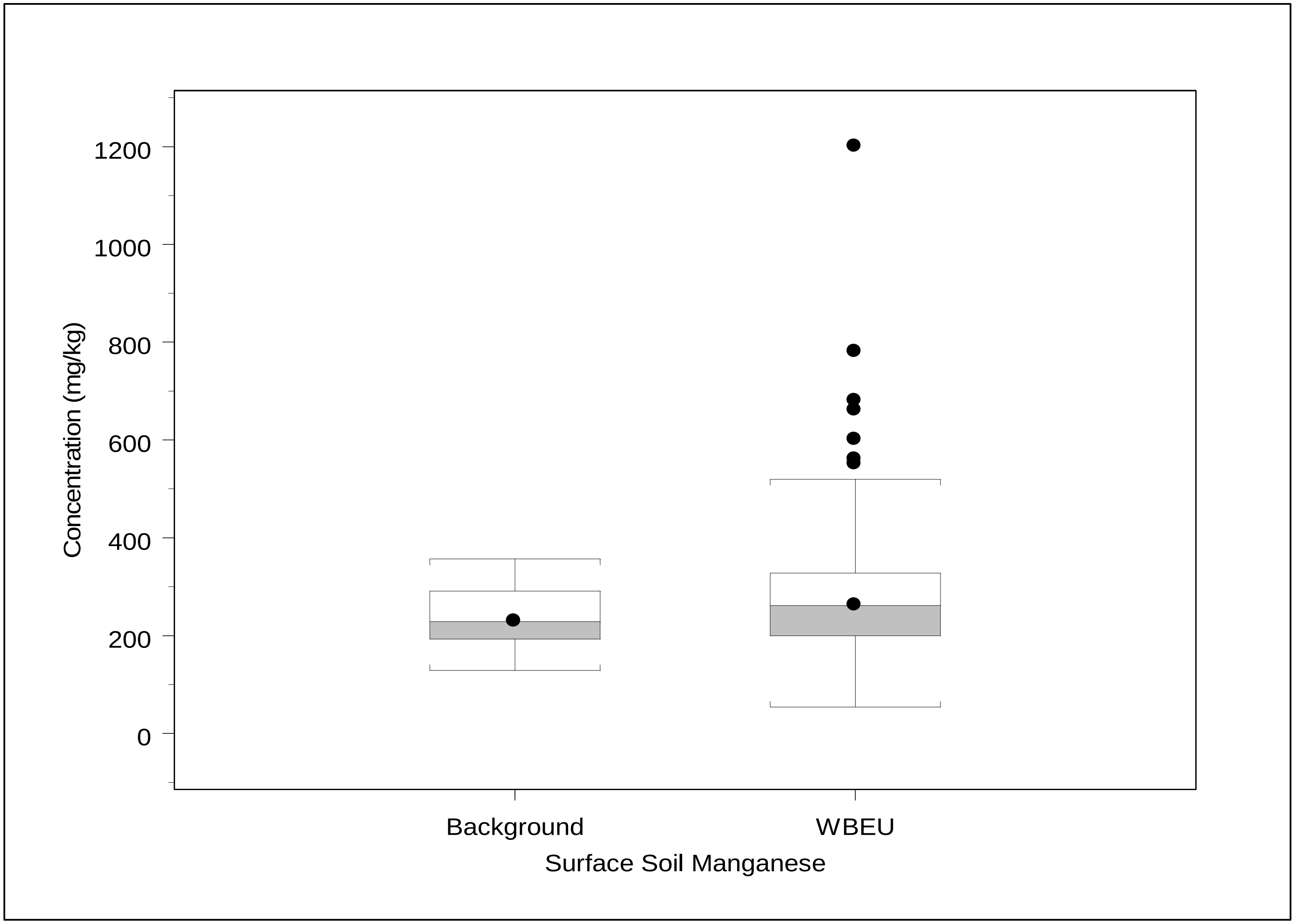

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.14**
**WBEU Surface Soil Box Plots for Lithium**



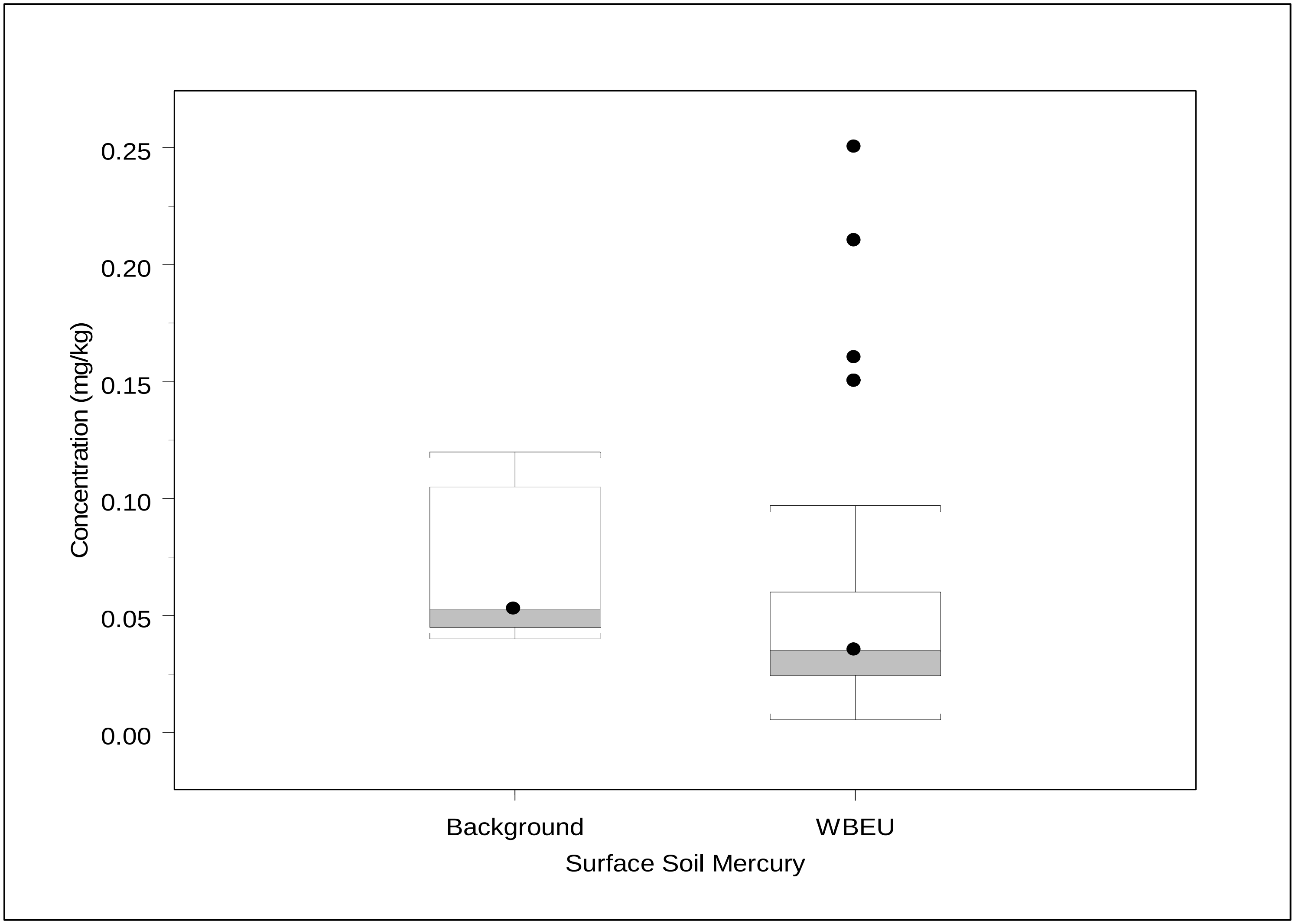

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.15**
**WBEU Surface Soil Box Plots for Manganese**



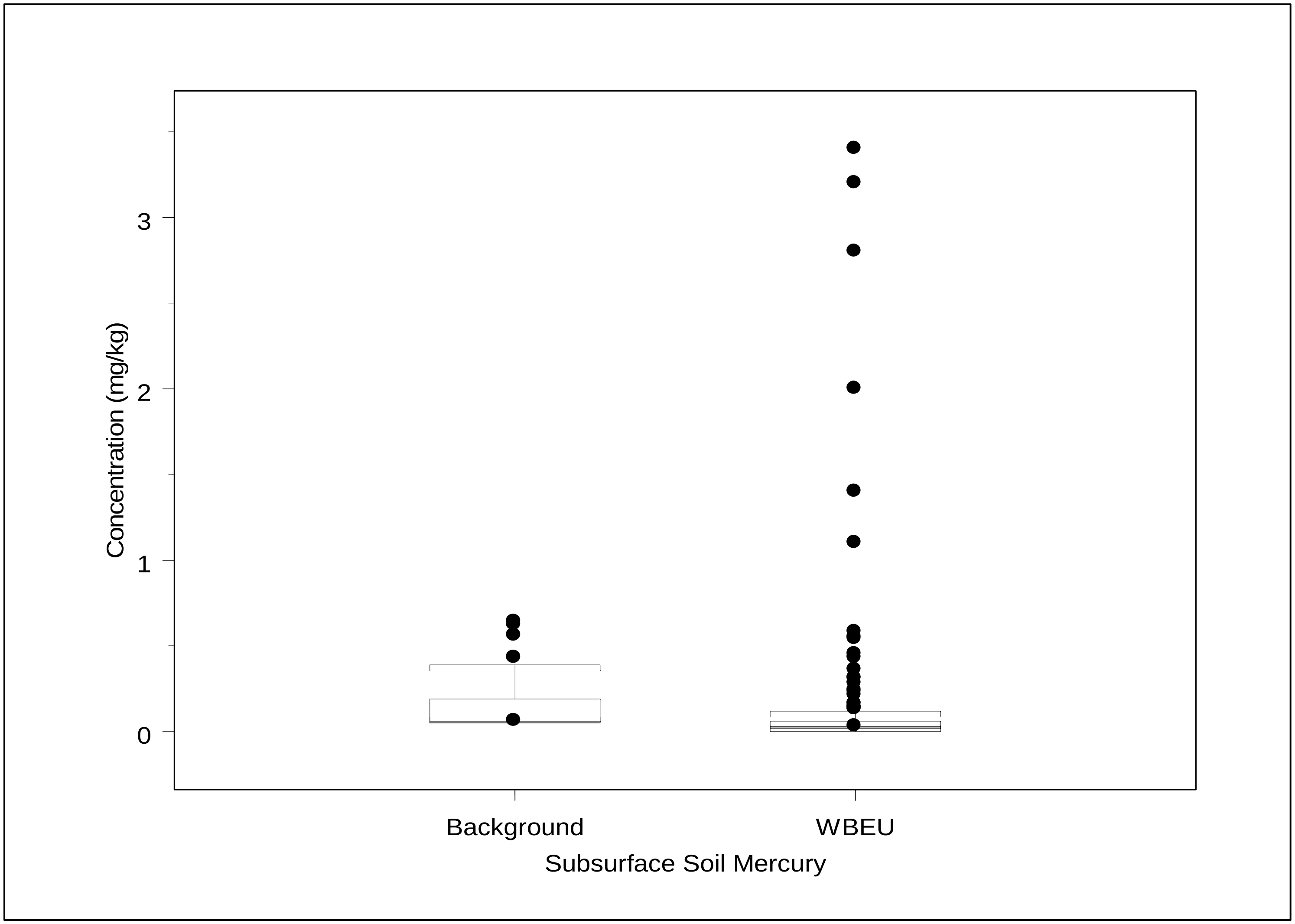

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.16**
**WBEU Surface Soil Box Plots for Mercury**



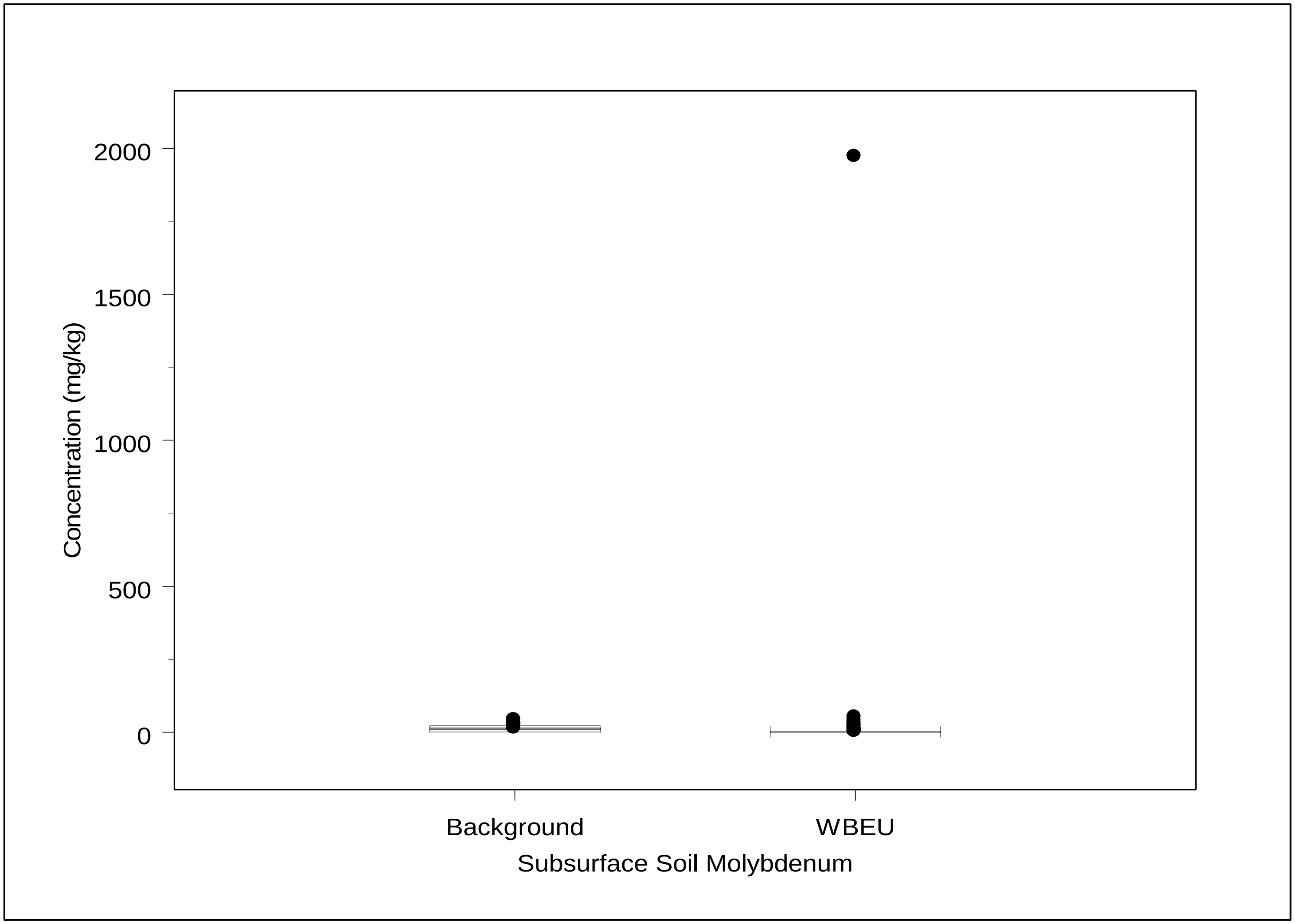

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.17**
**WBEU Subsurface Soil Box Plots for Mercury**



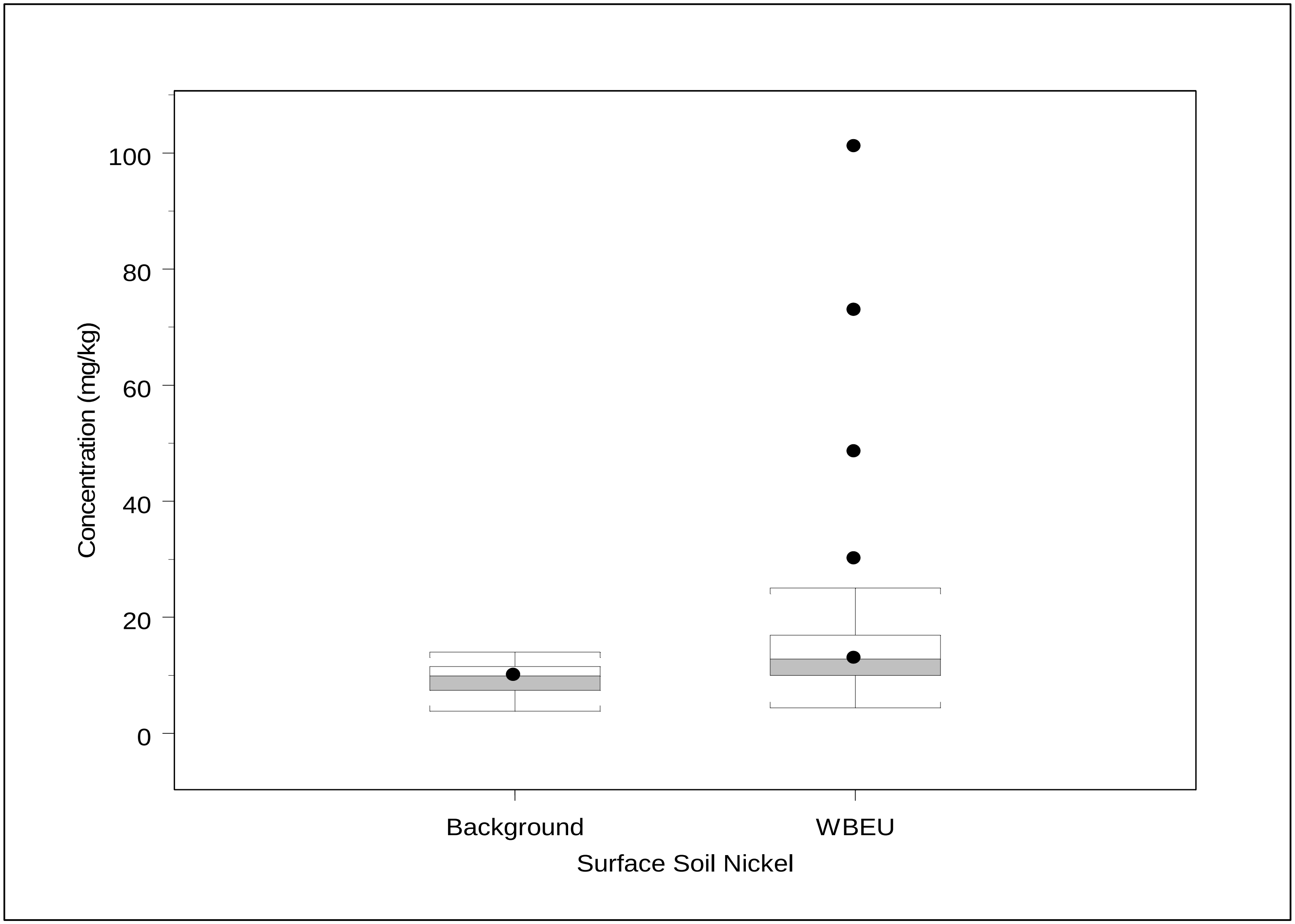

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.18**
**WBEU Subsurface Soil Box Plots for Molybdenum**



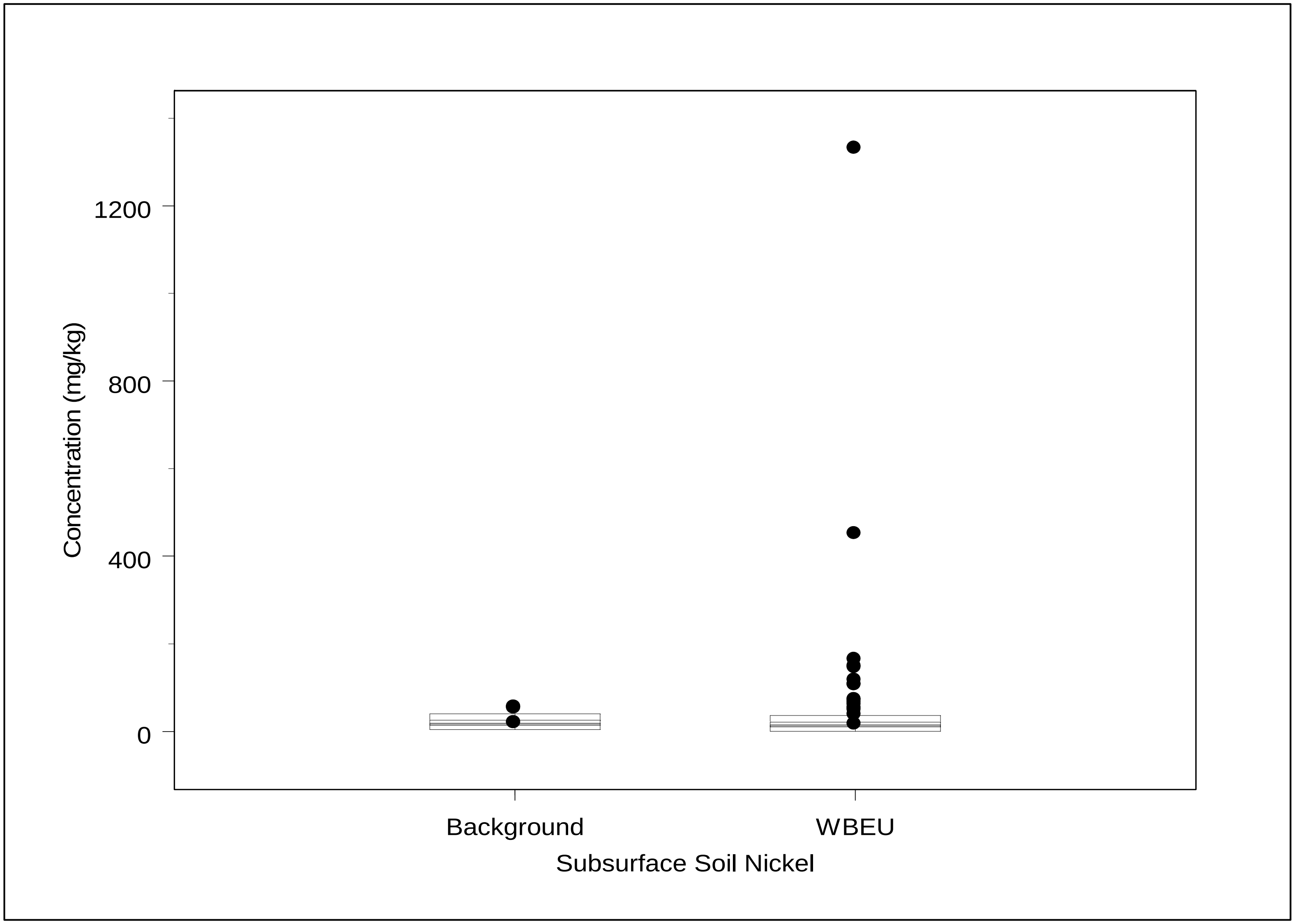

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.19**
**WBEU Surface Soil Box Plots for Nickel**



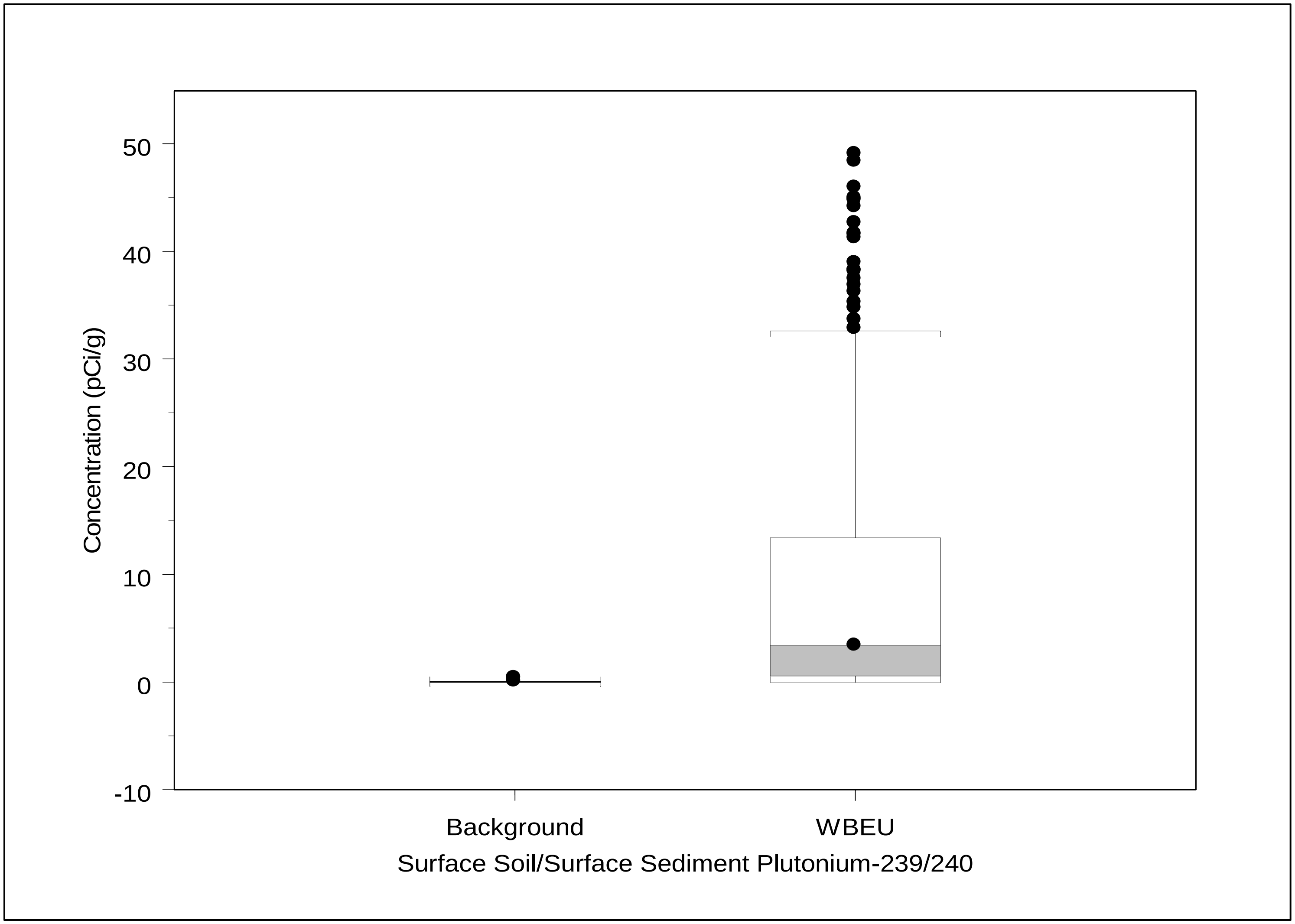

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.20**
**WBEU Subsurface Soil Box Plots for Nickel**



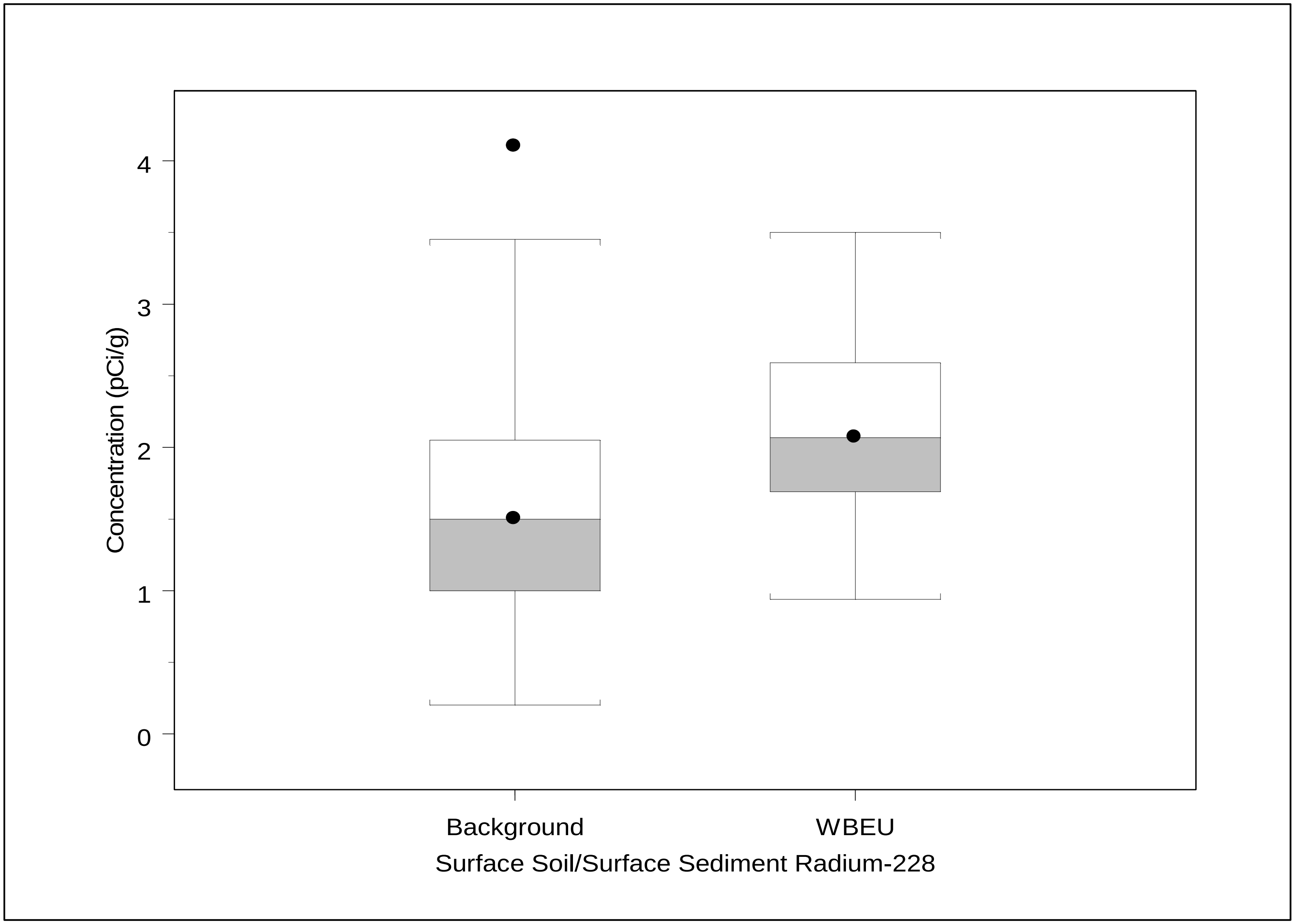

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.21**
**WBEU Surface Soil/Surface Sediment Box Plots for Plutonium-239/240**



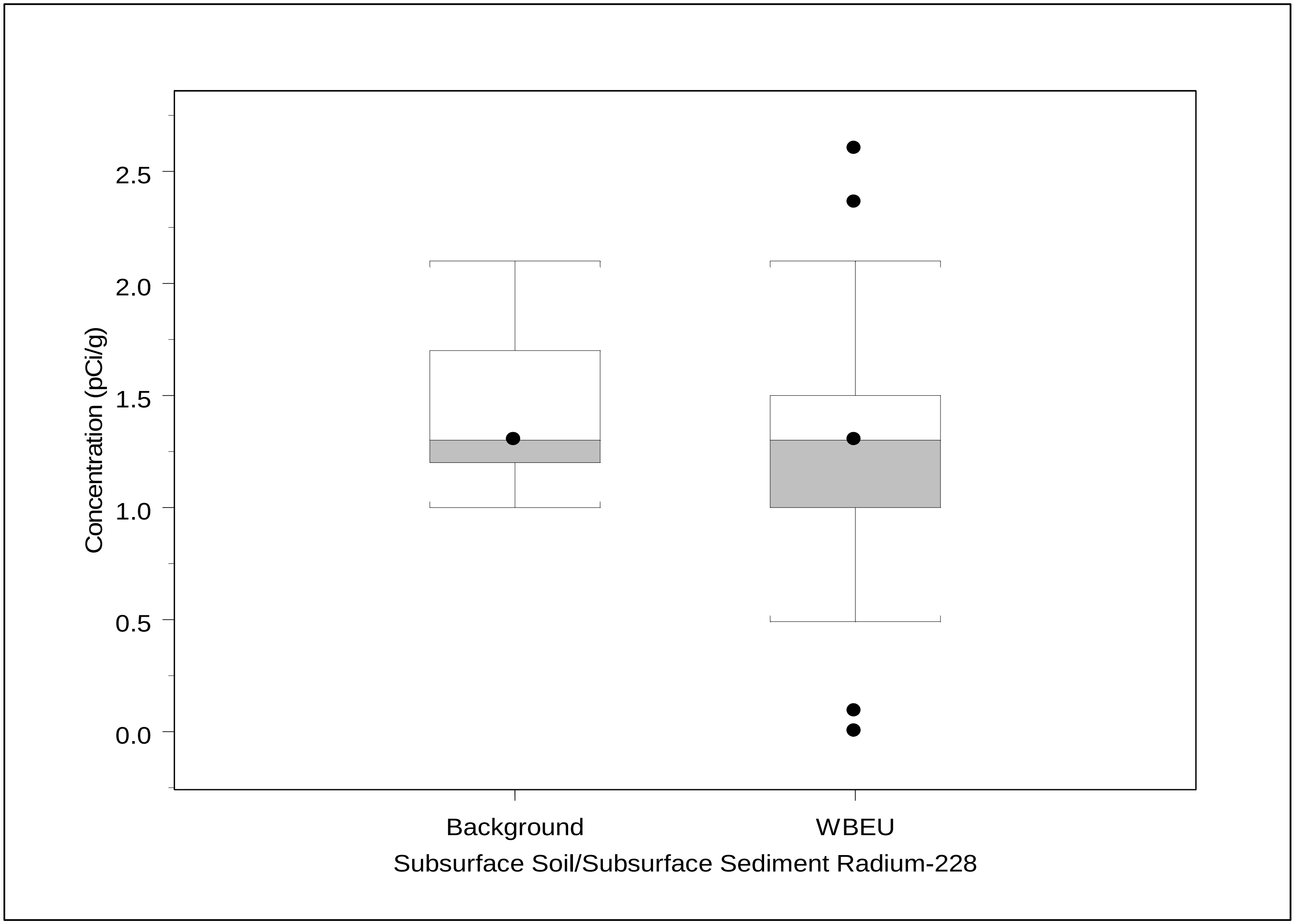

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.22**
**WBEU Surface Soil/Surface Sediment Box Plots for Radium-228**



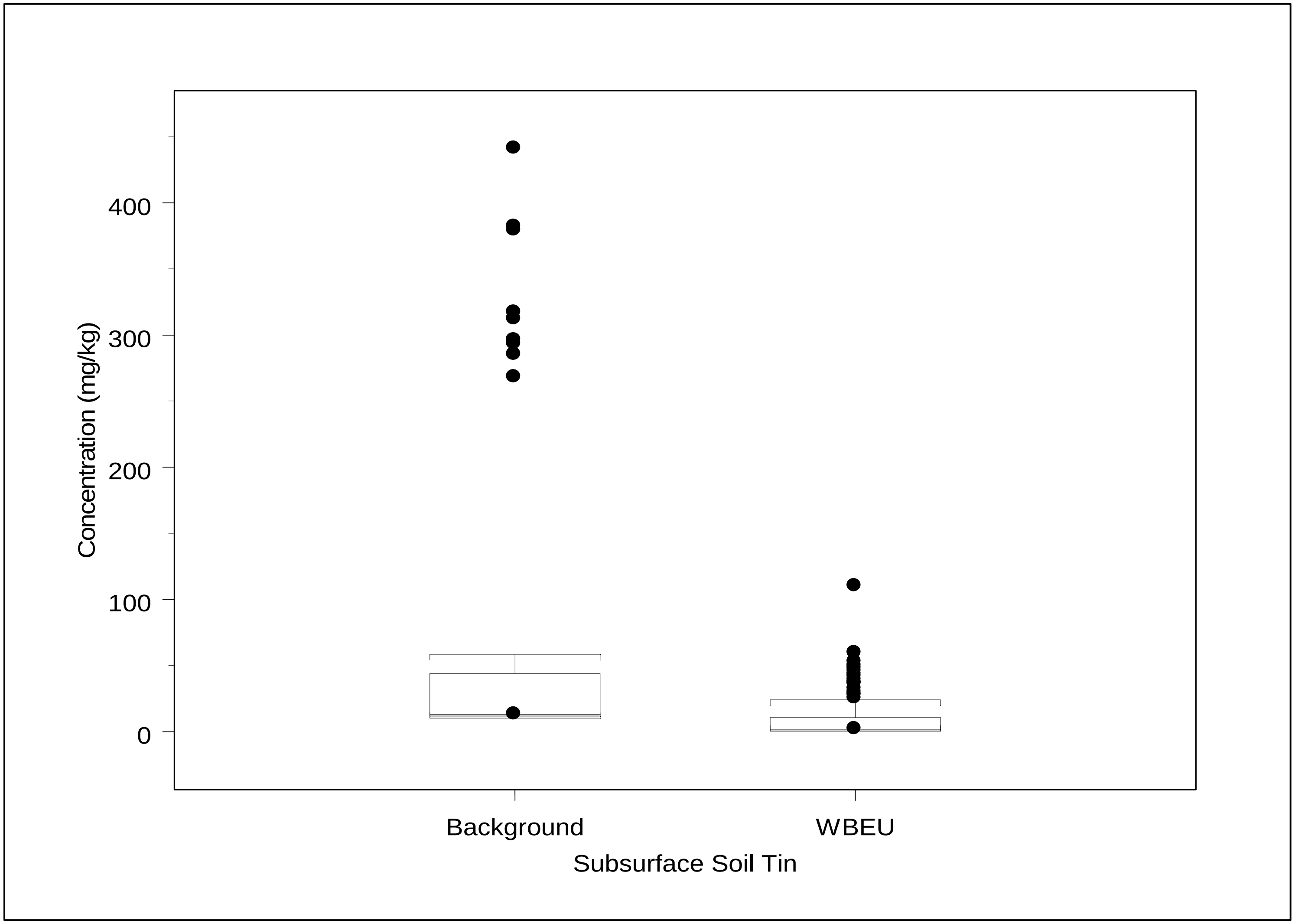

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.23**
**WBEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228**



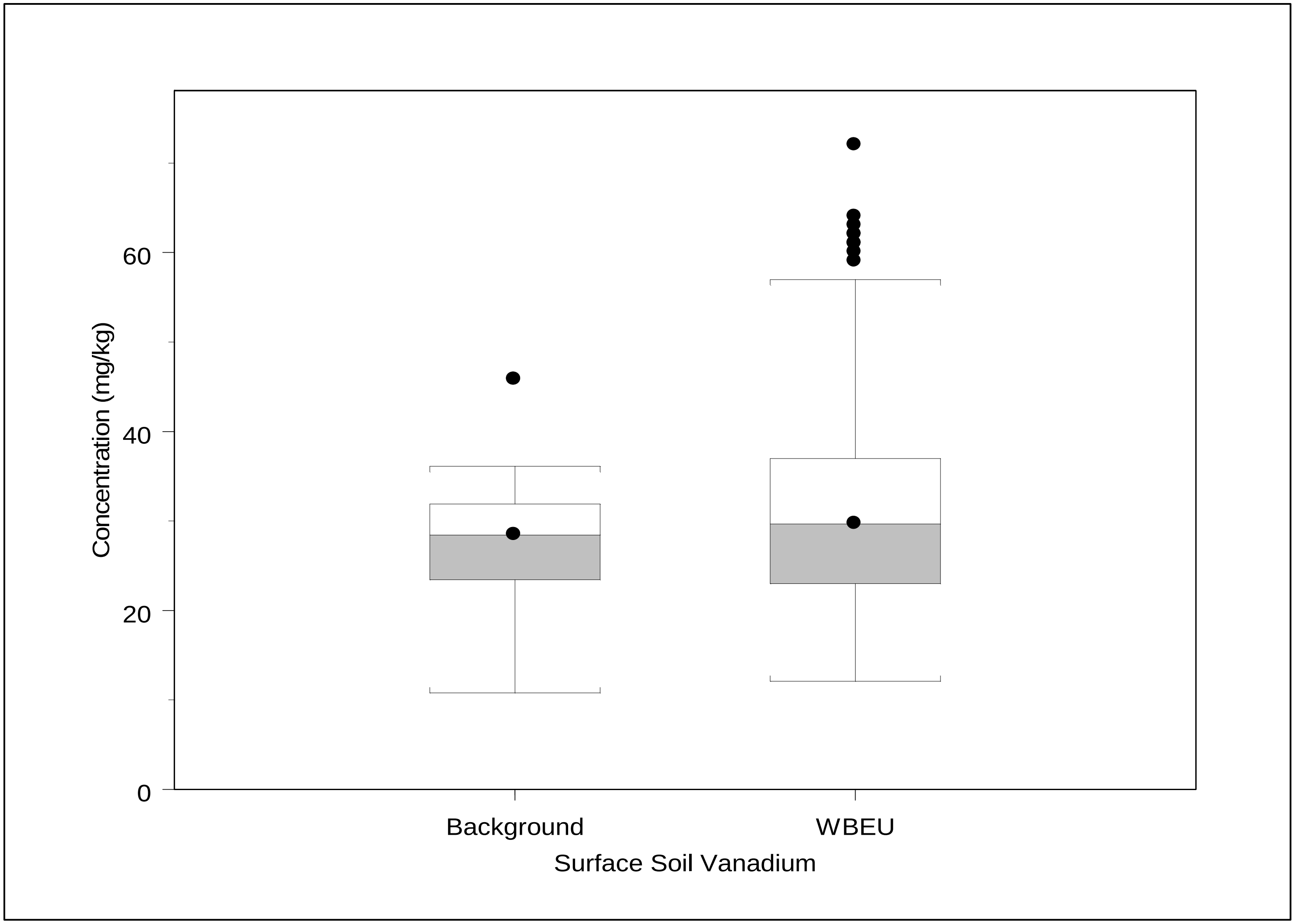

Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.24**
**WBEU Subsurface Soil Box Plots for Tin**




Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.25**
**WBEU Surface Soil Box Plots for Vanadium**




Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

**Figure A3.2.26**
**WBEU Surface Soil Box Plots for Zinc**


Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

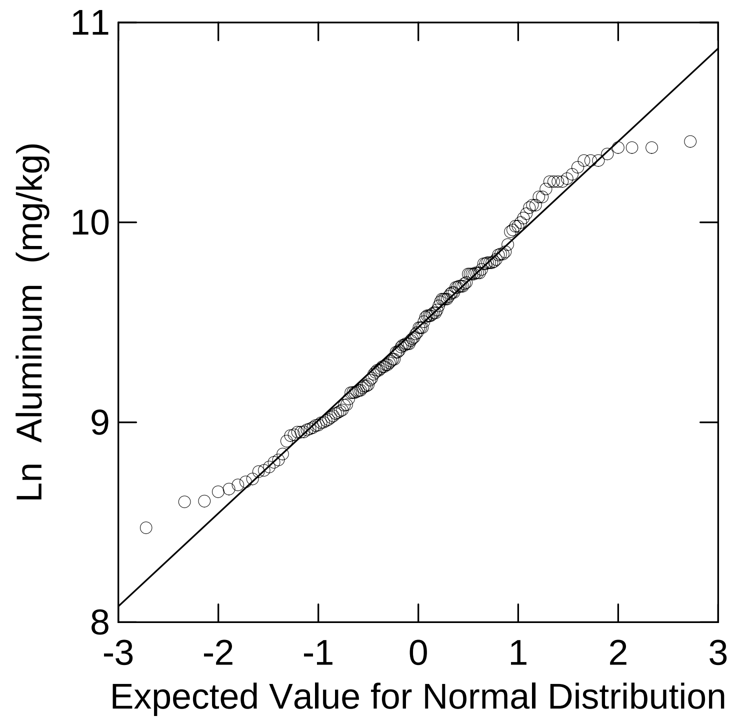



**Figure A3.4.1 Probability Plot for Aluminum Concentrations (Natural Logarithm) in WBEU Surface Soil**

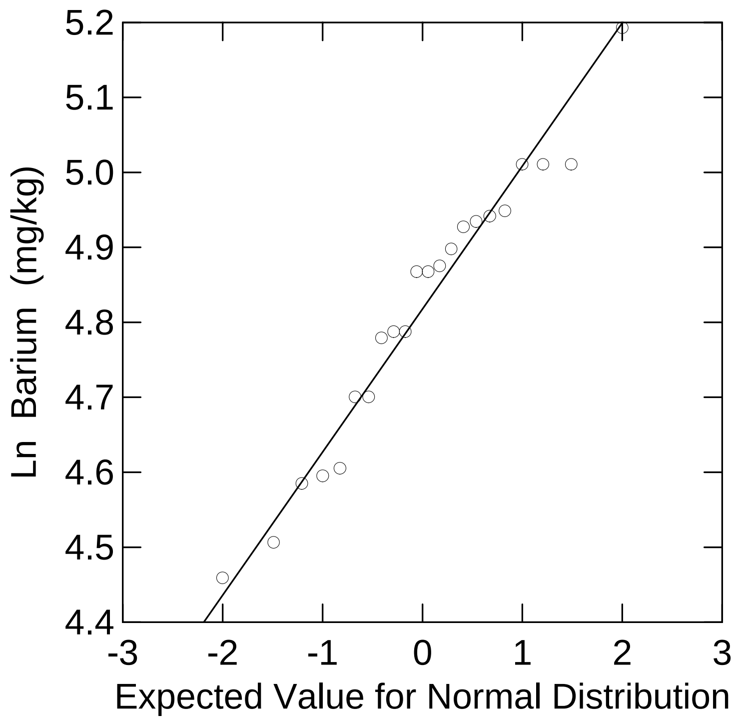
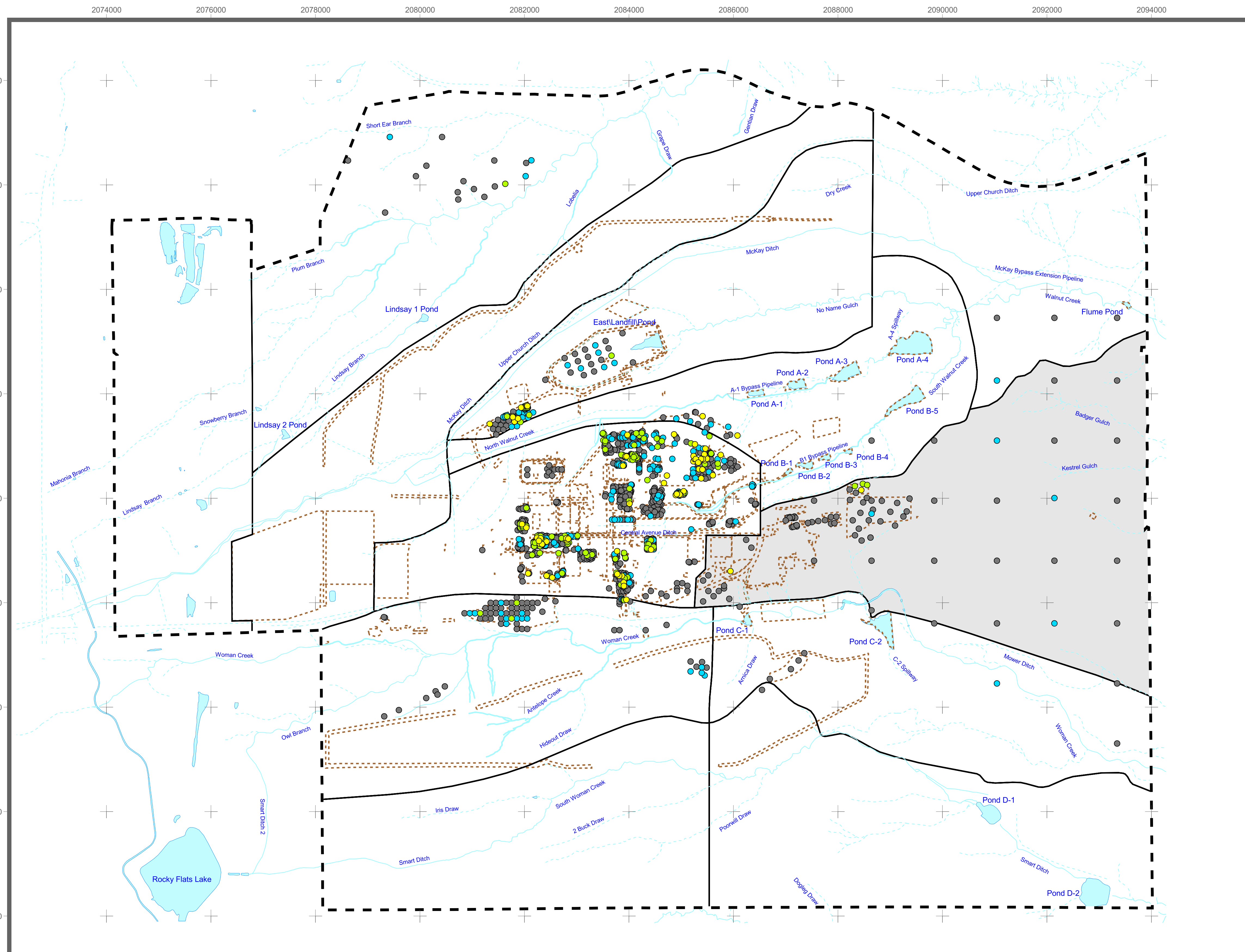



**Figure A3.4.2. Probability Plot for Barium Concentrations (Natural Logarithm) in WBEU Surface Soil.**




# Figure A3.4.3

**Bis(2-ethylhexyl)phthalate Concentrations in Sitewide Surface Soil (Non-PMJM)**

## KEY

- Concentration > 3x ESL
- Concentration > ESL and <= 3x ESL
- Concentration <= ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 137 ug/kg
3 x Min. Non-PMJM ESL = 410 ug/kg

### Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental Technology Site

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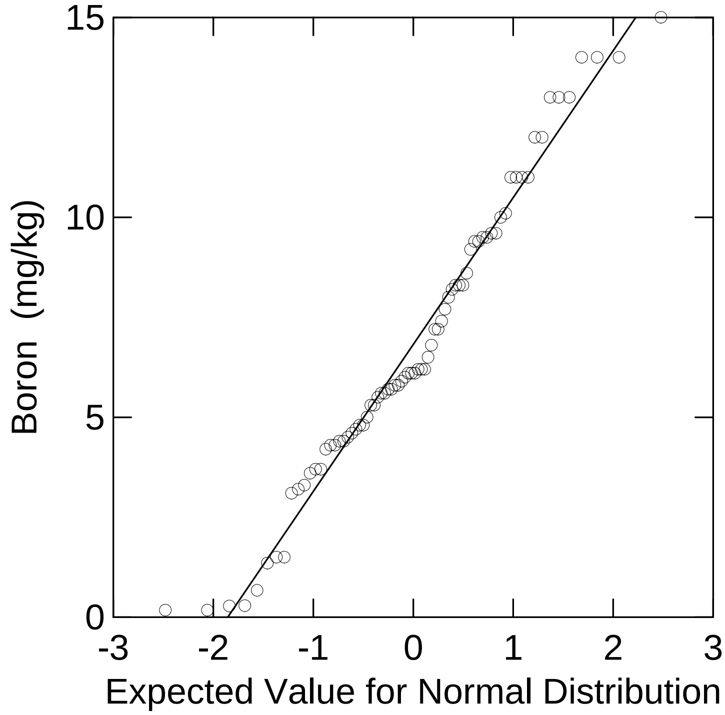
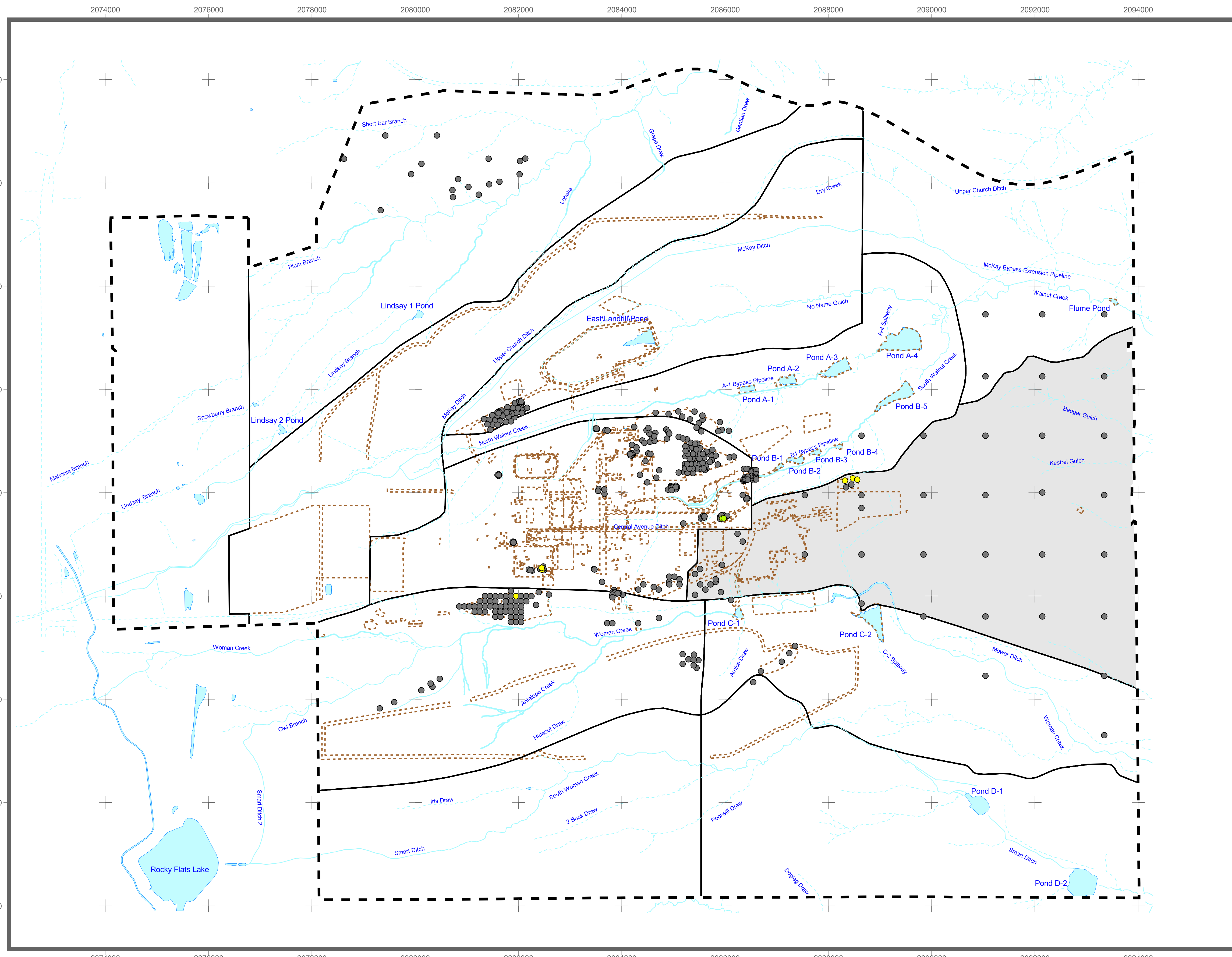



**Figure A3.4.4 Probability Plot for Boron Concentrations (Natural Logarithm) in WBEU Surface Soil**

## Figure A3.4.5

**Endrin Concentrations in Sitewide Surface Soil (Non-PMJM)**




## KEY

- Concentration > 3x ESL
- Concentration > ESL and <= 3x ESL
- Concentration <= ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 1.40 ug/kg
3 x Min. Non-PMJM ESL = 4.19 ug/kg

### Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
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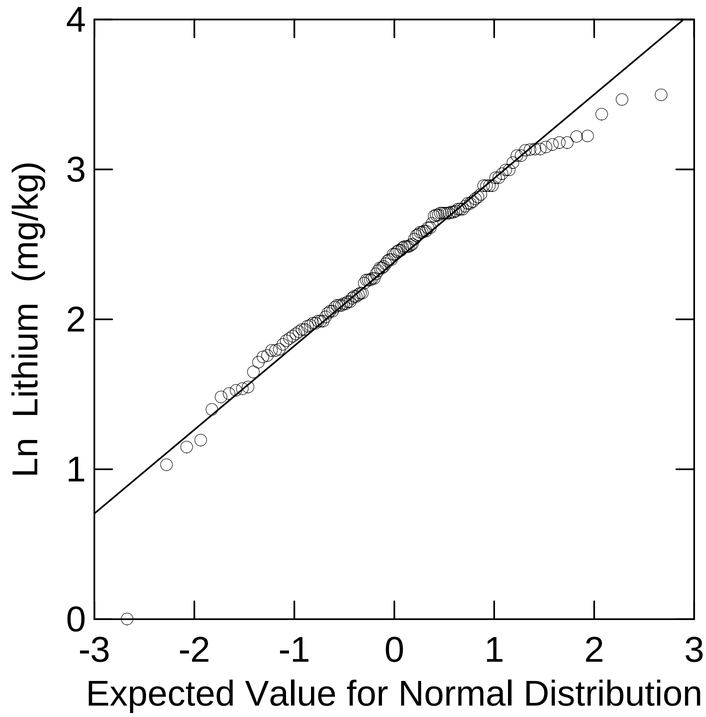



**Figure A3.4.6. Probability Plot for Lithium Concentrations (Natural Logarithm) in WBEU Surface Soil**

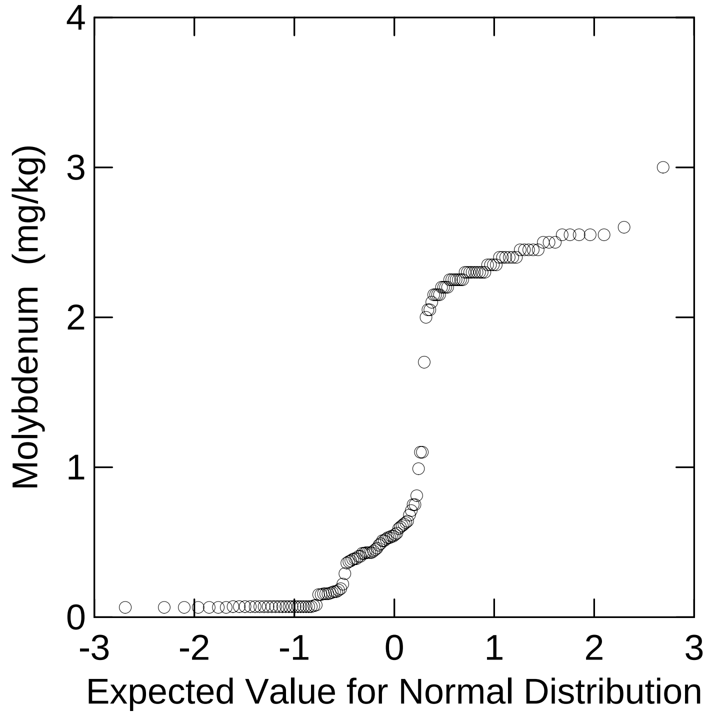
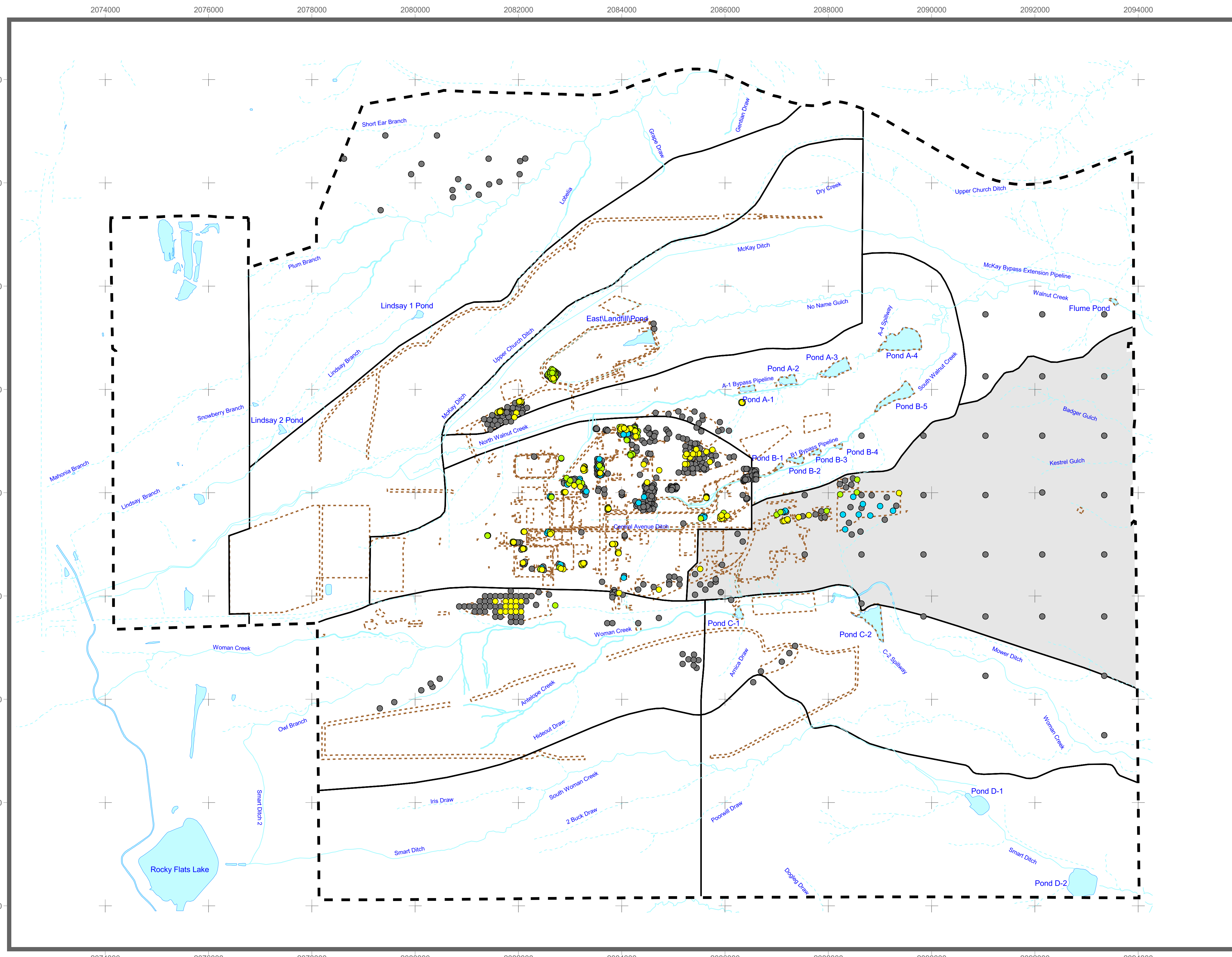



**Figure A3.4.7 Probability Plot for Molybdenum Concentrations in WBEU Surface Soil**

**Figure A3.4.8**

**Total PCB Concentrations in Sitewide Surface Soil (Non-PMJM)**




## KEY

- Concentration > 3x ESL
- Concentration > ESL and <= 3x ESL
- Concentration <= ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 42.3 ug/kg
3x Min. Non-PMJM ESL = 127 ug/kg

### Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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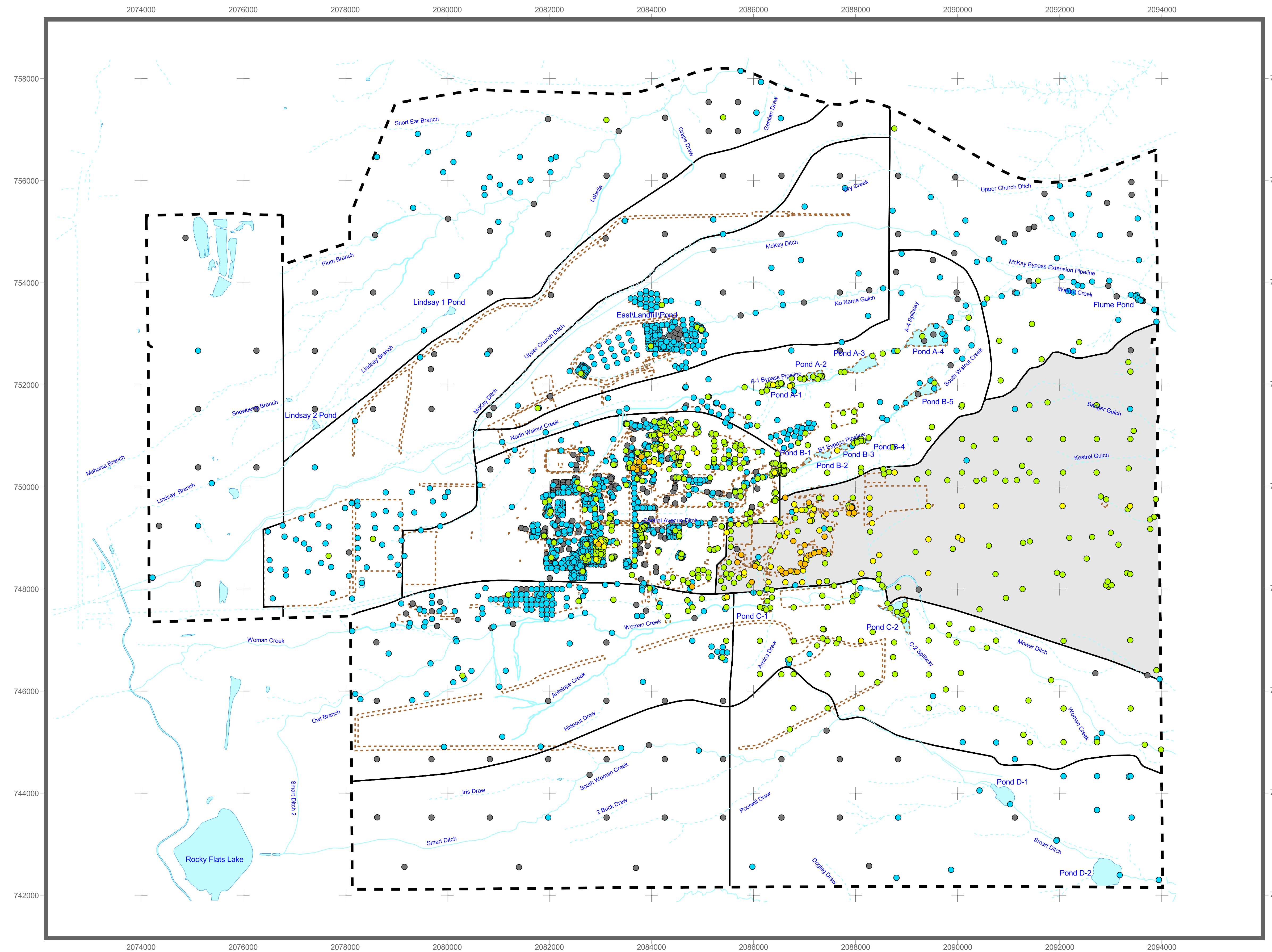


## Figure A3.4.9

**Plutonium-239/240 Activity in Sitewide Surface Soil/Surface Sediment**

### KEY

- Concentration > 3x WRW PRG
- Concentration > WRW PRG and <= 3x WRW PRG
- Concentration > Background MDC and <= WRW PRG
- Concentration <= Background MDC
- Nondetect (ND)

Background MDC = 0.350 pCi/g
WRW PRG = 9.80 pCi/g
3 x WRW PRG = 29.4 pCi/g

### Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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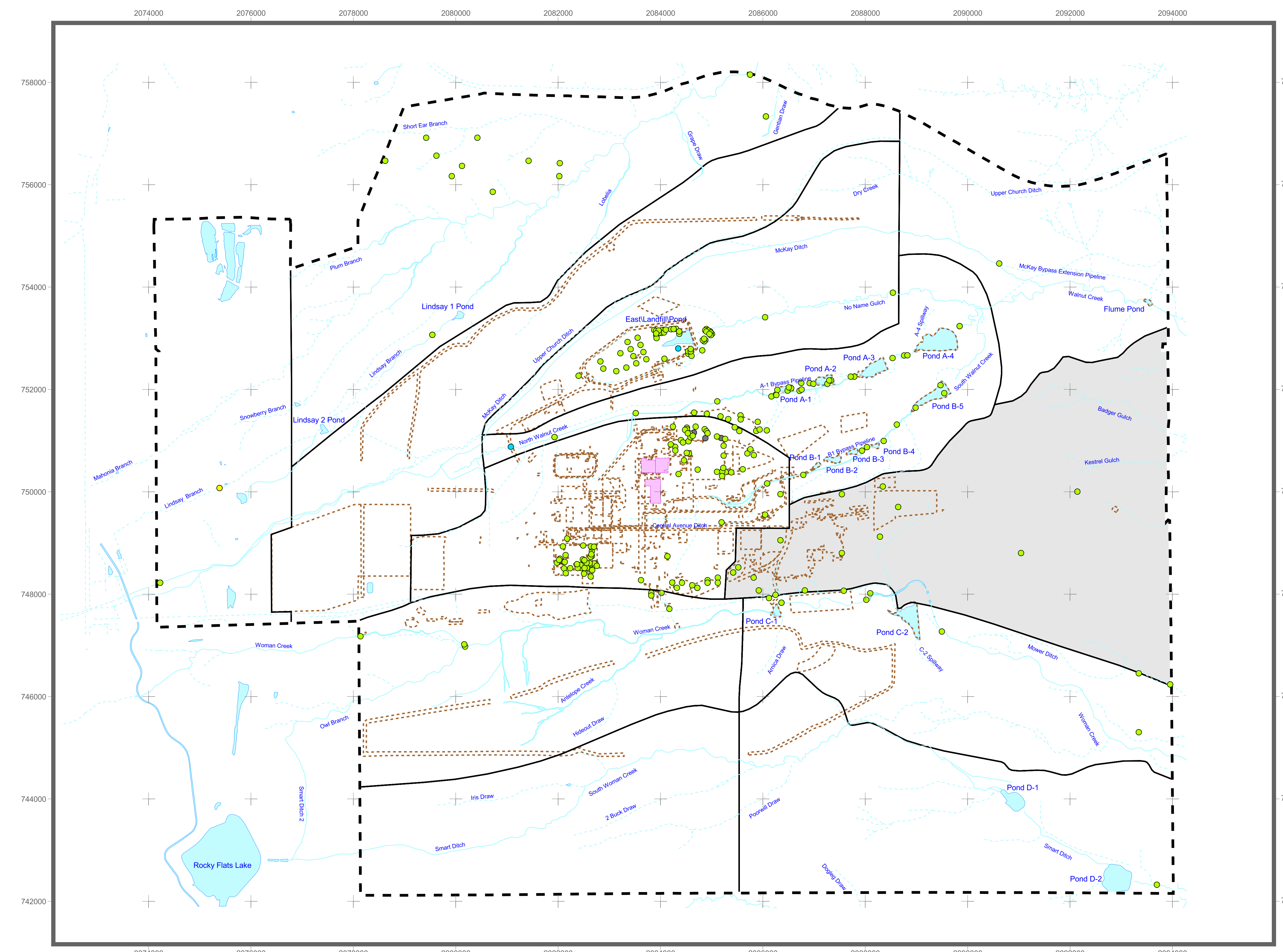


# Figure A3.4.10

## Radium-228 Activity in Sitewide Surface Soil/Surface Sediment

## KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and <= 3x Background MDC
- Concentration > WRW PRG and <= Background MDC
- Concentration <= WRW PRG
- Nondetect (ND)

WRW PRG = 0.111 pCi/g
Background MDC = 4.10 pCi/g
3 x Background MDC = 12.3 pCi/g

### Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental Technology Site

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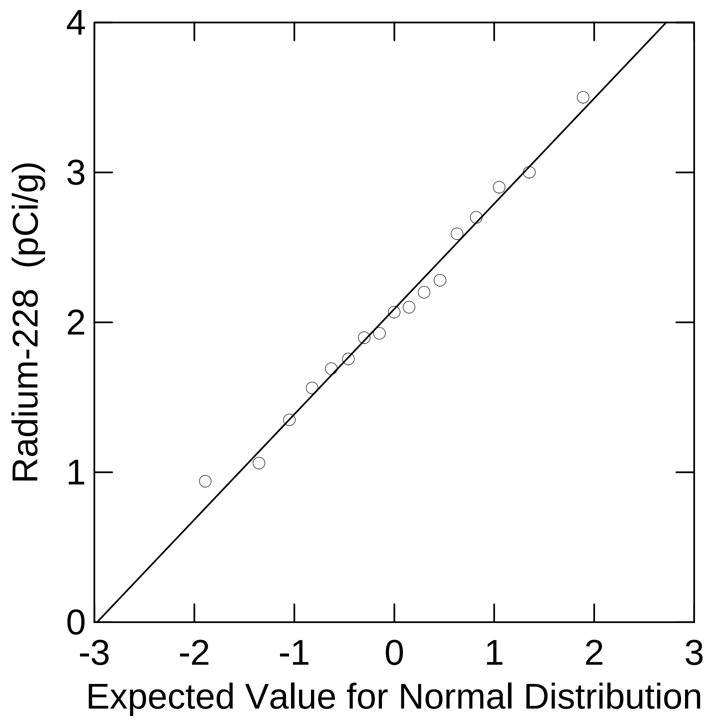


**Figure A3.4.11 Probability Plot for Radium-228 Activities (Natural Logarithm) in WBEU Surface Soil/Surface Sediment**

# COMPREHENSIVE RISK ASSESSMENT

## WIND BLOWN AREA EXPOSURE UNIT

## VOLUME 9: ATTACHMENT 4

## Risk Assessment Calculations

## TABLE OF CONTENTS

# RESRAD OUTPUT

# WILDLIFE REFUGE WORKER – TIER 1

Table of Contents

I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: 91918581.LIB

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Ac-227+D | 6.720E+00 | 6.720E+00 | DCF2( 1) |
| B-1 | Pa-231 | 1.280E+00 | 1.280E+00 | DCF2( 2) |
| B-1 | Pu-239 | 1.900E-01 | 4.290E-01 | DCF2( 3) |
| B-1 | U-235+D | 1.100E-02 | 1.230E-01 | DCF2( 4) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Ac-227+D | 1.480E-02 | 1.480E-02 | DCF3( 1) |
| D-1 | Pa-231 | 1.060E-02 | 1.060E-02 | DCF3( 2) |
| D-1 | Pu-239 | 9.300E-04 | 3.540E-03 | DCF3( 3) |
| D-1 | U-235+D | 1.720E-03 | 2.670E-04 | DCF3( 4) |
| | | | | |
| D-34 | Food transfer factors: | | | |
| D-34 | Ac-227+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 1,1) |
| D-34 | Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-05 | 2.000E-05 | RTF( 1,2) |
| D-34 | Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-05 | 2.000E-05 | RTF( 1,3) |
| D-34 | | | | |
| D-34 | Pa-231 , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 2,1) |
| D-34 | Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 2,2) |
| D-34 | Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 5.000E-06 | 5.000E-06 | RTF( 2,3) |
| D-34 | | | | |
| D-34 | Pu-239 , plant/soil concentration ratio, dimensionless | 5.800E-05 | 1.000E-03 | RTF( 3,1) |
| D-34 | Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 3,2) |
| D-34 | Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 1.000E-06 | 1.000E-06 | RTF( 3,3) |
| D-34 | | | | |
| D-34 | U-235+D , plant/soil concentration ratio, dimensionless | 6.000E-03 | 2.500E-03 | RTF( 4,1) |
| D-34 | U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 4,2) |
| D-34 | U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 4,3) |
| | | | | |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Ac-227+D , fish | 1.500E+01 | 1.500E+01 | BIOFAC( 1,1) |
| D-5 | Ac-227+D , crustacea and mollusks | 1.000E+03 | 1.000E+03 | BIOFAC( 1,2) |
| D-5 | | | | |
| D-5 | Pa-231 , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 2,1) |
| D-5 | Pa-231 , crustacea and mollusks | 1.100E+02 | 1.100E+02 | BIOFAC( 2,2) |
| D-5 | | | | |
| D-5 | Pu-239 , fish | 3.000E+01 | 3.000E+01 | BIOFAC( 3,1) |
| D-5 | Pu-239 , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 3,2) |
| D-5 | | | | |
| D-5 | U-235+D , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 4,1) |
| D-5 | U-235+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 4,2) |

Site-Specific Parameter Summary

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 1.400E+06 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 1.500E-01 | 2.000E+00 | --- | THICK0 |
| R011 | Length parallel to aquifer flow (m) | not used | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 2.500E+01 | 2.500E+01 | --- | BRDL |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 3.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 3.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 3.000E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 1.000E+03 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T( 9) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T(10) |
| | | | | | |
| R012 | Initial principal radionuclide (pCi/g): Pu-239 | 1.210E+01 | 0.000E+00 | --- | S1( 3) |
| R012 | Concentration in groundwater (pCi/L): Pu-239 | not used | 0.000E+00 | --- | W1( 3) |
| | | | | | |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.500E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.700E+00 | 1.500E+00 | --- | DENSCZ |
| R013 | Contaminated zone erosion rate (m/yr) | 7.490E-05 | 1.000E-03 | --- | VCZ |
| R013 | Contaminated zone total porosity | 3.000E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone field capacity | 1.000E-01 | 2.000E-01 | --- | FCCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 4.450E+01 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 1.040E+01 | 5.300E+00 | --- | BCZ |
| R013 | Average annual wind speed (m/sec) | 4.200E+00 | 2.000E+00 | --- | WIND |
| R013 | Humidity in air (g/m**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 2.530E-01 | 5.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 3.810E-01 | 1.000E+00 | --- | PRECIP |
| R013 | Irrigation (m/yr) | 0.000E+00 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 4.000E-03 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | not used | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | not used | 1.000E-03 | --- | EPS |
| | | | | | |
| R014 | Density of saturated zone (g/cm**3) | not used | 1.500E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | not used | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | not used | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone field capacity | not used | 2.000E-01 | --- | FCSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | not used | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | not used | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | not used | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | not used | 1.000E-03 | --- | VWT |
| R014 | Well pump intake depth (m below water table) | not used | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | not used | ND | --- | MODEL |
| R014 | Well pumping rate (m**3/yr) | not used | 2.500E+02 | --- | UW |
| | | | | | |
| R015 | Number of unsaturated zone strata | not used | 1 | --- | NS |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R015 | Unsat. zone 1, thickness (m) | not used | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | not used | 1.500E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | not used | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | not used | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, field capacity | not used | 2.000E-01 | --- | FCUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | not used | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | not used | 1.000E+01 | --- | HCUZ(1) |
| | | | | | |
| R016 | Distribution coefficients for Pu-239 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.300E+03 | 2.000E+03 | --- | DCNUCC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 2.000E+03 | --- | DCNUCU( 3,1) |
| R016 | Saturated zone (cm**3/g) | not used | 2.000E+03 | --- | DCNUCS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.833E-04 | ALEACH( 3) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 3) |
| | | | | | |
| R016 | Distribution coefficients for daughter Ac-227 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCNUCC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 2.000E+01 | --- | DCNUCU( 1,1) |
| R016 | Saturated zone (cm**3/g) | not used | 2.000E+01 | --- | DCNUCS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 5.519E-02 | ALEACH( 1) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 1) |
| | | | | | |
| R016 | Distribution coefficients for daughter Pa-231 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCNUCC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 5.000E+01 | --- | DCNUCU( 2,1) |
| R016 | Saturated zone (cm**3/g) | not used | 5.000E+01 | --- | DCNUCS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.217E-02 | ALEACH( 2) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 2) |
| | | | | | |
| R016 | Distribution coefficients for daughter U-235 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.300E+00 | 5.000E+01 | --- | DCNUCC( 4) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 5.000E+01 | --- | DCNUCU( 4,1) |
| R016 | Saturated zone (cm**3/g) | not used | 5.000E+01 | --- | DCNUCS( 4) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.551E-01 | ALEACH( 4) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 4) |
| | | | | | |
| R017 | Inhalation rate (m**3/yr) | 1.400E+04 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 6.700E-05 | 1.000E-04 | --- | MLINH |
| R017 | Exposure duration | 3.000E+01 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 7.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 4.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 1.140E-01 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 1.140E-01 | 2.500E-01 | --- | FOTD |
| R017 | Shape factor flag, external gamma | 1.000E+00 | 1.000E+00 | >0 shows circular AREA. | FS |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R017 | Radii of shape factor array (used if FS = -1): | | | | |
| R017 | Outer annular radius (m), ring 1: | not used | 5.000E+01 | --- | RAD_SHAPE( 1) |
| R017 | Outer annular radius (m), ring 2: | not used | 7.071E+01 | --- | RAD_SHAPE( 2) |
| R017 | Outer annular radius (m), ring 3: | not used | 0.000E+00 | --- | RAD_SHAPE( 3) |
| R017 | Outer annular radius (m), ring 4: | not used | 0.000E+00 | --- | RAD_SHAPE( 4) |
| R017 | Outer annular radius (m), ring 5: | not used | 0.000E+00 | --- | RAD_SHAPE( 5) |
| R017 | Outer annular radius (m), ring 6: | not used | 0.000E+00 | --- | RAD_SHAPE( 6) |
| R017 | Outer annular radius (m), ring 7: | not used | 0.000E+00 | --- | RAD_SHAPE( 7) |
| R017 | Outer annular radius (m), ring 8: | not used | 0.000E+00 | --- | RAD_SHAPE( 8) |
| R017 | Outer annular radius (m), ring 9: | not used | 0.000E+00 | --- | RAD_SHAPE( 9) |
| R017 | Outer annular radius (m), ring 10: | not used | 0.000E+00 | --- | RAD_SHAPE(10) |
| R017 | Outer annular radius (m), ring 11: | not used | 0.000E+00 | --- | RAD_SHAPE(11) |
| R017 | Outer annular radius (m), ring 12: | not used | 0.000E+00 | --- | RAD_SHAPE(12) |
| | | | | | |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Ring 1 | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Ring 2 | not used | 2.732E-01 | --- | FRACA( 2) |
| R017 | Ring 3 | not used | 0.000E+00 | --- | FRACA( 3) |
| R017 | Ring 4 | not used | 0.000E+00 | --- | FRACA( 4) |
| R017 | Ring 5 | not used | 0.000E+00 | --- | FRACA( 5) |
| R017 | Ring 6 | not used | 0.000E+00 | --- | FRACA( 6) |
| R017 | Ring 7 | not used | 0.000E+00 | --- | FRACA( 7) |
| R0 | Ring 8 | not used | 0.000E+00 | --- | FRACA( 8) |
| R0 | Ring 9 | not used | 0.000E+00 | --- | FRACA( 9) |
| R017 | Ring 10 | not used | 0.000E+00 | --- | FRACA(10) |
| R017 | Ring 11 | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Ring 12 | not used | 0.000E+00 | --- | FRACA(12) |
| | | | | | |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | not used | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | not used | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | not used | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | not used | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | not used | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | not used | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 1.095E+02 | 3.650E+01 | --- | SOIL |
| R018 | Drinking water intake (L/yr) | not used | 5.100E+02 | --- | DWI |
| R018 | Contamination fraction of drinking water | not used | 1.000E+00 | --- | FDW |
| R018 | Contamination fraction of household water | not used | 1.000E+00 | --- | FHHW |
| R018 | Contamination fraction of livestock water | not used | 1.000E+00 | --- | FLW |
| R018 | Contamination fraction of irrigation water | not used | 1.000E+00 | --- | FIRW |
| R018 | Contamination fraction of aquatic food | not used | 5.000E-01 | --- | FR9 |
| R018 | Contamination fraction of plant food | not used | -1 | --- | FPLANT |
| R018 | Contamination fraction of meat | not used | -1 | --- | FMEAT |
| R018 | Contamination fraction of milk | not used | -1 | --- | FMILK |
| | | | | | |
| R019 | Livestock fodder intake for meat (kg/day) | not used | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | not used | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | not used | 5.000E+01 | --- | LWI5 |
| R0 | Livestock water intake for milk (L/day) | not used | 1.600E+02 | --- | LWI6 |
| R019 | Livestock soil intake (kg/day) | not used | 5.000E-01 | --- | LSI |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R019 | Mass loading for foliar deposition (g/m**3) | not used | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | not used | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | not used | 1.000E+00 | --- | FGWDW |
| R019 | Household water fraction from ground water | not used | 1.000E+00 | --- | FGWHH |
| R019 | Livestock water fraction from ground water | not used | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | not used | 1.000E+00 | --- | FGWIR |
| | | | | | |
| R19B | Wet weight crop yield for Non-Leafy (kg/m**2) | not used | 7.000E-01 | --- | YV(1) |
| R19B | Wet weight crop yield for Leafy (kg/m**2) | not used | 1.500E+00 | --- | YV(2) |
| R19B | Wet weight crop yield for Fodder (kg/m**2) | not used | 1.100E+00 | --- | YV(3) |
| R19B | Growing Season for Non-Leafy (years) | not used | 1.700E-01 | --- | TE(1) |
| R19B | Growing Season for Leafy (years) | not used | 2.500E-01 | --- | TE(2) |
| R19B | Growing Season for Fodder (years) | not used | 8.000E-02 | --- | TE(3) |
| R19B | Translocation Factor for Non-Leafy | not used | 1.000E-01 | --- | TIV(1) |
| R19B | Translocation Factor for Leafy | not used | 1.000E+00 | --- | TIV(2) |
| R19B | Translocation Factor for Fodder | not used | 1.000E+00 | --- | TIV(3) |
| R19B | Dry Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RDRY(1) |
| R19B | Dry Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RDRY(2) |
| R19B | Dry Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RDRY(3) |
| R19B | Wet Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RWET(1) |
| R19B | Wet Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RWET(2) |
| R19B | Wet Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RWET(3) |
| R19B | Weathering Removal Constant for Vegetation | not used | 2.000E+01 | --- | WLAM |
| | | | | | |
| C14 | C-12 concentration in water (g/cm**3) | not used | 2.000E-05 | --- | C12WTR |
| C14 | C-12 concentration in contaminated soil (g/g) | not used | 3.000E-02 | --- | C12CZ |
| C14 | Fraction of vegetation carbon from soil | not used | 2.000E-02 | --- | CSOIL |
| C14 | Fraction of vegetation carbon from air | not used | 9.800E-01 | --- | CAIR |
| C14 | C-14 evasion layer thickness in soil (m) | not used | 3.000E-01 | --- | DMC |
| C14 | C-14 evasion flux rate from soil (1/sec) | not used | 7.000E-07 | --- | EVSN |
| C14 | C-12 evasion flux rate from soil (1/sec) | not used | 1.000E-10 | --- | REVSN |
| C14 | Fraction of grain in beef cattle feed | not used | 8.000E-01 | --- | AVFG4 |
| C14 | Fraction of grain in milk cow feed | not used | 2.000E-01 | --- | AVFG5 |
| C14 | DCF correction factor for gaseous forms of C14 | not used | 1.234E+02 | --- | CO2F |
| | | | | | |
| STOR | Storage times of contaminated foodstuffs (days): | | | | |
| STOR | Fruits, non-leafy vegetables, and grain | 1.400E+01 | 1.400E+01 | --- | STOR_T(1) |
| STOR | Leafy vegetables | 1.000E+00 | 1.000E+00 | --- | STOR_T(2) |
| STOR | Milk | 1.000E+00 | 1.000E+00 | --- | STOR_T(3) |
| STOR | Meat and poultry | 2.000E+01 | 2.000E+01 | --- | STOR_T(4) |
| STOR | Fish | 7.000E+00 | 7.000E+00 | --- | STOR_T(5) |
| STOR | Crustacea and mollusks | 7.000E+00 | 7.000E+00 | --- | STOR_T(6) |
| STOR | Well water | 1.000E+00 | 1.000E+00 | --- | STOR_T(7) |
| STOR | Surface water | 1.000E+00 | 1.000E+00 | --- | STOR_T(8) |
| STOR | Livestock fodder | 4.500E+01 | 4.500E+01 | --- | STOR_T(9) |
| | | | | | |
| R021 | Thickness of building foundation (m) | not used | 1.500E-01 | --- | FLOOR1 |
| R021 | Bulk density of building foundation (g/cm**3) | not used | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R021 | Total porosity of the building foundation | not used | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | not used | 5.000E-02 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | not used | 3.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | not used | 3.000E-07 | --- | DIFFL |
| R021 | in contaminated zone soil | not used | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | not used | 2.000E+00 | --- | HMIX |
| R021 | Average building air exchange rate (1/hr) | not used | 5.000E-01 | --- | REXG |
| R021 | Height of the building (room) (m) | not used | 2.500E+00 | --- | HRM |
| R021 | Building interior area factor | not used | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | not used | -1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | not used | 2.500E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | not used | 1.500E-01 | --- | EMANA(2) |
| | | | | | |
| TITL | Number of graphical time points | 32 | --- | --- | NPTS |
| TITL | Maximum number of integration points for dose | 17 | --- | --- | LYMAX |
| TITL | Maximum number of integration points for risk | 257 | --- | --- | KYMAX |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation (w/o radon) | active |
| 3 -- plant ingestion | suppressed |
| 4 -- meat ingestion | suppressed |
| 5 -- milk ingestion | suppressed |
| 6 -- aquatic foods | suppressed |
| 7 -- drinking water | suppressed |
| 8 -- soil ingestion | active |
| 9 -- radon | suppressed |
| Find peak pathway doses | active |

Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown EU
File : WBWRW.RAD

| Contaminated Zone Dimensions | | Initial Soil Concentrations, pCi/g | |
|---|---|---|---|
| Area: | 1400000.00 square meters | Pu-239 | 1.210E+01 |
| Thickness: | 0.15 meters | | |
| Cover Depth: | 0.00 meters | | |

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

| t (years): | 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| TDOSE(t): | 3.391E-01 | 3.388E-01 | 3.381E-01 | 3.357E-01 | 3.290E-01 | 3.061E-01 | 2.473E-01 | 1.018E-01 |
| M(t): | 1.357E-02 | 1.355E-02 | 1.352E-02 | 1.343E-02 | 1.316E-02 | 1.225E-02 | 9.893E-03 | 4.074E-03 |

Maximum TDOSE(t): 3.391E-01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.550E-04 | 0.0016 | 5.778E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.808E-01 | 0.8280 |
| Total | 5.550E-04 | 0.0016 | 5.778E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.808E-01 | 0.8280 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.391E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.391E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.547E-04 | 0.0016 | 5.772E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.805E-01 | 0.8280 |
| Total | 5.547E-04 | 0.0016 | 5.772E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.805E-01 | 0.8280 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.388E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.388E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.540E-04 | 0.0016 | 5.760E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.799E-01 | 0.8280 |
| Total | 5.540E-04 | 0.0016 | 5.760E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.799E-01 | 0.8280 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.381E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.381E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.519E-04 | 0.0016 | 5.720E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.780E-01 | 0.8280 |
| Total | 5.519E-04 | 0.0016 | 5.720E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.780E-01 | 0.8280 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.357E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.357E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.457E-04 | 0.0017 | 5.605E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.724E-01 | 0.8280 |
| Total | 5.457E-04 | 0.0017 | 5.605E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.724E-01 | 0.8280 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.290E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.290E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.247E-04 | 0.0017 | 5.215E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.535E-01 | 0.8279 |
| Total | 5.247E-04 | 0.0017 | 5.215E-02 | 0.1704 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.535E-01 | 0.8279 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.061E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.061E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown EU
File : WBWRW.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | 4.675E-04 | 0.0019 | 4.213E-02 | 0.1703 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.047E-01 | 0.8278 |
| Total | 4.675E-04 | 0.0019 | 4.213E-02 | 0.1703 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.047E-01 | 0.8278 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

| Radio-Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.473E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.473E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 2.925E-04 | 0.0029 | 1.733E-02 | 0.1702 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.422E-02 | 0.8270 |
| Total | 2.925E-04 | 0.0029 | 1.733E-02 | 0.1702 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.422E-02 | 0.8270 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.018E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.018E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

| Parent (i) | Product (j) | Branch Fraction* | DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 2.803E-02 | 2.800E-02 | 2.794E-02 | 2.775E-02 | 2.719E-02 | 2.530E-02 | 2.044E-02 | 8.417E-03 |
| Pu-239 | U-235 | 1.000E+00 | 6.836E-11 | 1.704E-10 | 2.760E-10 | 3.427E-10 | 3.410E-10 | 3.249E-10 | 2.822E-10 | 1.598E-10 |
| Pu-239 | Pa-231 | 1.000E+00 | 1.008E-15 | 6.220E-15 | 2.535E-14 | 1.119E-13 | 3.062E-13 | 5.499E-13 | 5.077E-13 | 2.186E-13 |
| Pu-239 | Ac-227 | 1.000E+00 | 2.088E-17 | 2.797E-16 | 2.566E-15 | 3.287E-14 | 1.959E-13 | 5.068E-13 | 5.027E-13 | 2.441E-13 |
| Pu-239 | ∑DSR(j) | | 2.803E-02 | 2.800E-02 | 2.794E-02 | 2.775E-02 | 2.719E-02 | 2.530E-02 | 2.044E-02 | 8.417E-03 |

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

| Nuclide (i) | t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| Pu-239 | 8.920E+02 | 8.929E+02 | 8.947E+02 | 9.010E+02 | 9.195E+02 | 9.881E+02 | 1.223E+03 | 2.970E+03 |

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

| Nuclide (i) | Initial pCi/g | tmin (years) | DSR(i,tmin) | G(i,tmin) (pCi/g) | DSR(i,tmax) | G(i,tmax) (pCi/g) |
|---|---|---|---|---|---|---|
| Pu-239 | 1.210E+01 | 0.000E+00 | 2.803E-02 | 8.920E+02 | 2.803E-02 | 8.920E+02 |

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | BRF(i) | DOSE(j,t), mrem/yr t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 3.391E-01 | 3.388E-01 | 3.381E-01 | 3.357E-01 | 3.290E-01 | 3.061E-01 | 2.473E-01 | 1.018E-01 |
| U-235 | Pu-239 | 1.000E+00 | 8.272E-10 | 2.062E-09 | 3.339E-09 | 4.147E-09 | 4.126E-09 | 3.932E-09 | 3.414E-09 | 1.934E-09 |
| Pa-231 | Pu-239 | 1.000E+00 | 1.219E-14 | 7.526E-14 | 3.067E-13 | 1.354E-12 | 3.705E-12 | 6.653E-12 | 6.143E-12 | 2.645E-12 |
| Ac-227 | Pu-239 | 1.000E+00 | 2.527E-16 | 3.384E-15 | 3.105E-14 | 3.977E-13 | 2.371E-12 | 6.132E-12 | 6.082E-12 | 2.954E-12 |

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | BRF(i) | S(j,t), pCi/g t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 1.210E+01 | 1.209E+01 | 1.208E+01 | 1.204E+01 | 1.192E+01 | 1.150E+01 | 1.038E+01 | 7.251E+00 |
| U-235 | Pu-239 | 1.000E+00 | 0.000E+00 | 9.571E-09 | 1.948E-08 | 2.580E-08 | 2.582E-08 | 2.491E-08 | 2.248E-08 | 1.571E-08 |
| Pa-231 | Pu-239 | 1.000E+00 | 0.000E+00 | 1.081E-13 | 7.369E-13 | 3.948E-12 | 1.139E-11 | 2.139E-11 | 2.191E-11 | 1.533E-11 |
| Ac-227 | Pu-239 | 1.000E+00 | 0.000E+00 | 1.166E-15 | 2.433E-14 | 4.274E-13 | 2.778E-12 | 7.512E-12 | 8.058E-12 | 5.642E-12 |

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.82 seconds

# RESRAD OUTPUT

# WILDLIFE REFUGE VISITOR – ADULT – TIER 1

Table of Contents

## I: Mixture Sums and Single Radionuclide Guidelines

## Dose Conversion Factor (and Related) Parameter Summary

File: 91918581.LIB

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Ac-227+D | 6.720E+00 | 6.720E+00 | DCF2( 1) |
| B-1 | Pa-231 | 1.280E+00 | 1.280E+00 | DCF2( 2) |
| B-1 | Pu-239 | 1.900E-01 | 4.290E-01 | DCF2( 3) |
| B-1 | U-235+D | 1.100E-02 | 1.230E-01 | DCF2( 4) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Ac-227+D | 1.480E-02 | 1.480E-02 | DCF3( 1) |
| D-1 | Pa-231 | 1.060E-02 | 1.060E-02 | DCF3( 2) |
| D-1 | Pu-239 | 9.300E-04 | 3.540E-03 | DCF3( 3) |
| D-1 | U-235+D | 1.720E-03 | 2.670E-04 | DCF3( 4) |
| | | | | |
| D-34 | Food transfer factors: | | | |
| D-34 | Ac-227+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 1,1) |
| D-34 | Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-05 | 2.000E-05 | RTF( 1,2) |
| D-34 | Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-05 | 2.000E-05 | RTF( 1,3) |
| D-34 | | | | |
| D-34 | Pa-231 , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 2,1) |
| D-34 | Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 2,2) |
| D-34 | Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 5.000E-06 | 5.000E-06 | RTF( 2,3) |
| D-34 | | | | |
| D-34 | Pu-239 , plant/soil concentration ratio, dimensionless | 5.800E-05 | 1.000E-03 | RTF( 3,1) |
| D-34 | Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 3,2) |
| D-34 | Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 1.000E-06 | 1.000E-06 | RTF( 3,3) |
| D-34 | | | | |
| D-34 | U-235+D , plant/soil concentration ratio, dimensionless | 6.000E-03 | 2.500E-03 | RTF( 4,1) |
| D-34 | U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 4,2) |
| D-34 | U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 4,3) |
| | | | | |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Ac-227+D , fish | 1.500E+01 | 1.500E+01 | BIOFAC( 1,1) |
| D-5 | Ac-227+D , crustacea and mollusks | 1.000E+03 | 1.000E+03 | BIOFAC( 1,2) |
| D-5 | | | | |
| D-5 | Pa-231 , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 2,1) |
| D-5 | Pa-231 , crustacea and mollusks | 1.100E+02 | 1.100E+02 | BIOFAC( 2,2) |
| D-5 | | | | |
| D-5 | Pu-239 , fish | 3.000E+01 | 3.000E+01 | BIOFAC( 3,1) |
| D-5 | Pu-239 , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 3,2) |
| D-5 | | | | |
| D-5 | U-235+D , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 4,1) |
| D-5 | U-235+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 4,2) |

Site-Specific Parameter Summary

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 1.400E+06 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 1.500E-01 | 2.000E+00 | --- | THICK0 |
| R011 | Length parallel to aquifer flow (m) | not used | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 2.500E+01 | 2.500E+01 | --- | BRDL |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 3.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 3.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 3.000E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 1.000E+03 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T( 9) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T(10) |
| | | | | | |
| R012 | Initial principal radionuclide (pCi/g): Pu-239 | 1.210E+01 | 0.000E+00 | --- | S1( 3) |
| R012 | Concentration in groundwater (pCi/L): Pu-239 | not used | 0.000E+00 | --- | W1( 3) |
| | | | | | |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.500E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.700E+00 | 1.500E+00 | --- | DENSCZ |
| R0 | Contaminated zone erosion rate (m/yr) | 7.490E-05 | 1.000E-03 | --- | VCZ |
| R0. | Contaminated zone total porosity | 3.000E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone field capacity | 1.000E-01 | 2.000E-01 | --- | FCCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 4.450E+01 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 1.040E+01 | 5.300E+00 | --- | BCZ |
| R013 | Average annual wind speed (m/sec) | 4.200E+00 | 2.000E+00 | --- | WIND |
| R013 | Humidity in air (g/m**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 2.530E-01 | 5.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 3.810E-01 | 1.000E+00 | --- | PRECIP |
| R013 | Irrigation (m/yr) | 0.000E+00 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 4.000E-03 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | not used | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | not used | 1.000E-03 | --- | EPS |
| | | | | | |
| R014 | Density of saturated zone (g/cm**3) | not used | 1.500E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | not used | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | not used | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone field capacity | not used | 2.000E-01 | --- | FCSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | not used | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | not used | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | not used | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | not used | 1.000E-03 | --- | VWT |
| R014 | Well pump intake depth (m below water table) | not used | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | not used | ND | --- | MODEL |
| R014 | Well pumping rate (m**3/yr) | not used | 2.500E+02 | --- | UW |
| | | | | | |
| R015 | Number of unsaturated zone strata | not used | 1 | --- | NS |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R015 | Unsat. zone 1, thickness (m) | not used | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | not used | 1.500E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | not used | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | not used | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, field capacity | not used | 2.000E-01 | --- | FCUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | not used | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | not used | 1.000E+01 | --- | HCUZ(1) |
| | | | | | |
| R016 | Distribution coefficients for Pu-239 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.300E+03 | 2.000E+03 | --- | DCNUCC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 2.000E+03 | --- | DCNUCU( 3,1) |
| R016 | Saturated zone (cm**3/g) | not used | 2.000E+03 | --- | DCNUCS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.833E-04 | ALEACH( 3) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 3) |
| | | | | | |
| R016 | Distribution coefficients for daughter Ac-227 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCNUCC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 2.000E+01 | --- | DCNUCU( 1,1) |
| R016 | Saturated zone (cm**3/g) | not used | 2.000E+01 | --- | DCNUCS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 5.519E-02 | ALEACH( 1) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 1) |
| | | | | | |
| R016 | Distribution coefficients for daughter Pa-231 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCNUCC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 5.000E+01 | --- | DCNUCU( 2,1) |
| R016 | Saturated zone (cm**3/g) | not used | 5.000E+01 | --- | DCNUCS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.217E-02 | ALEACH( 2) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 2) |
| | | | | | |
| R016 | Distribution coefficients for daughter U-235 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.300E+00 | 5.000E+01 | --- | DCNUCC( 4) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 5.000E+01 | --- | DCNUCU( 4,1) |
| R016 | Saturated zone (cm**3/g) | not used | 5.000E+01 | --- | DCNUCS( 4) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.551E-01 | ALEACH( 4) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 4) |
| | | | | | |
| R017 | Inhalation rate (m**3/yr) | 2.000E+04 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 6.700E-05 | 1.000E-04 | --- | MLINH |
| R017 | Exposure duration | 3.000E+01 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 7.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 4.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 0.000E+00 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 3.000E-02 | 2.500E-01 | --- | FOTD |
| R017 | Shape factor flag, external gamma | 1.000E+00 | 1.000E+00 | >0 shows circular AREA. | FS |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R017 | Radii of shape factor array (used if FS = -1): | | | | |
| R017 | Outer annular radius (m), ring 1: | not used | 5.000E+01 | --- | RAD_SHAPE( 1) |
| R017 | Outer annular radius (m), ring 2: | not used | 7.071E+01 | --- | RAD_SHAPE( 2) |
| R017 | Outer annular radius (m), ring 3: | not used | 0.000E+00 | --- | RAD_SHAPE( 3) |
| R017 | Outer annular radius (m), ring 4: | not used | 0.000E+00 | --- | RAD_SHAPE( 4) |
| R017 | Outer annular radius (m), ring 5: | not used | 0.000E+00 | --- | RAD_SHAPE( 5) |
| R017 | Outer annular radius (m), ring 6: | not used | 0.000E+00 | --- | RAD_SHAPE( 6) |
| R017 | Outer annular radius (m), ring 7: | not used | 0.000E+00 | --- | RAD_SHAPE( 7) |
| R017 | Outer annular radius (m), ring 8: | not used | 0.000E+00 | --- | RAD_SHAPE( 8) |
| R017 | Outer annular radius (m), ring 9: | not used | 0.000E+00 | --- | RAD_SHAPE( 9) |
| R017 | Outer annular radius (m), ring 10: | not used | 0.000E+00 | --- | RAD_SHAPE(10) |
| R017 | Outer annular radius (m), ring 11: | not used | 0.000E+00 | --- | RAD_SHAPE(11) |
| R017 | Outer annular radius (m), ring 12: | not used | 0.000E+00 | --- | RAD_SHAPE(12) |
| | | | | | |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Ring 1 | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Ring 2 | not used | 2.732E-01 | --- | FRACA( 2) |
| R017 | Ring 3 | not used | 0.000E+00 | --- | FRACA( 3) |
| R017 | Ring 4 | not used | 0.000E+00 | --- | FRACA( 4) |
| R017 | Ring 5 | not used | 0.000E+00 | --- | FRACA( 5) |
| R017 | Ring 6 | not used | 0.000E+00 | --- | FRACA( 6) |
| R017 | Ring 7 | not used | 0.000E+00 | --- | FRACA( 7) |
| R017 | Ring 8 | not used | 0.000E+00 | --- | FRACA( 8) |
| R017 | Ring 9 | not used | 0.000E+00 | --- | FRACA( 9) |
| R017 | Ring 10 | not used | 0.000E+00 | --- | FRACA(10) |
| R017 | Ring 11 | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Ring 12 | not used | 0.000E+00 | --- | FRACA(12) |
| | | | | | |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | not used | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | not used | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | not used | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | not used | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | not used | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | not used | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 1.752E+02 | 3.650E+01 | --- | SOIL |
| R018 | Drinking water intake (L/yr) | not used | 5.100E+02 | --- | DWI |
| R018 | Contamination fraction of drinking water | not used | 1.000E+00 | --- | FDW |
| R018 | Contamination fraction of household water | not used | 1.000E+00 | --- | FHHW |
| R018 | Contamination fraction of livestock water | not used | 1.000E+00 | --- | FLW |
| R018 | Contamination fraction of irrigation water | not used | 1.000E+00 | --- | FIRW |
| R018 | Contamination fraction of aquatic food | not used | 5.000E-01 | --- | FR9 |
| R018 | Contamination fraction of plant food | not used | -1 | --- | FPLANT |
| R018 | Contamination fraction of meat | not used | -1 | --- | FMEAT |
| R018 | Contamination fraction of milk | not used | -1 | --- | FMILK |
| | | | | | |
| R019 | Livestock fodder intake for meat (kg/day) | not used | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | not used | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | not used | 5.000E+01 | --- | LWI5 |
| R019 | Livestock water intake for milk (L/day) | not used | 1.600E+02 | --- | LWI6 |
| R019 | Livestock soil intake (kg/day) | not used | 5.000E-01 | --- | LSI |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R019 | Mass loading for foliar deposition (g/m**3) | not used | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | not used | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | not used | 1.000E+00 | --- | FGWDW |
| R019 | Household water fraction from ground water | not used | 1.000E+00 | --- | FGWHH |
| R019 | Livestock water fraction from ground water | not used | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | not used | 1.000E+00 | --- | FGWIR |
| | | | | | |
| R19B | Wet weight crop yield for Non-Leafy (kg/m**2) | not used | 7.000E-01 | --- | YV(1) |
| R19B | Wet weight crop yield for Leafy (kg/m**2) | not used | 1.500E+00 | --- | YV(2) |
| R19B | Wet weight crop yield for Fodder (kg/m**2) | not used | 1.100E+00 | --- | YV(3) |
| R19B | Growing Season for Non-Leafy (years) | not used | 1.700E-01 | --- | TE(1) |
| R19B | Growing Season for Leafy (years) | not used | 2.500E-01 | --- | TE(2) |
| R19B | Growing Season for Fodder (years) | not used | 8.000E-02 | --- | TE(3) |
| R19B | Translocation Factor for Non-Leafy | not used | 1.000E-01 | --- | TIV(1) |
| R19B | Translocation Factor for Leafy | not used | 1.000E+00 | --- | TIV(2) |
| R19B | Translocation Factor for Fodder | not used | 1.000E+00 | --- | TIV(3) |
| R19B | Dry Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RDRY(1) |
| R19B | Dry Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RDRY(2) |
| R19B | Dry Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RDRY(3) |
| R19B | Wet Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RWET(1) |
| R19B | Wet Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RWET(2) |
| R19B | Wet Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RWET(3) |
| R19B | Weathering Removal Constant for Vegetation | not used | 2.000E+01 | --- | WLAM |
| | | | | | |
| C14 | C-12 concentration in water (g/cm**3) | not used | 2.000E-05 | --- | C12WTR |
| C14 | C-12 concentration in contaminated soil (g/g) | not used | 3.000E-02 | --- | C12CZ |
| C14 | Fraction of vegetation carbon from soil | not used | 2.000E-02 | --- | CSOIL |
| C14 | Fraction of vegetation carbon from air | not used | 9.800E-01 | --- | CAIR |
| C14 | C-14 evasion layer thickness in soil (m) | not used | 3.000E-01 | --- | DMC |
| C14 | C-14 evasion flux rate from soil (1/sec) | not used | 7.000E-07 | --- | EVSN |
| C14 | C-12 evasion flux rate from soil (1/sec) | not used | 1.000E-10 | --- | REVSN |
| C14 | Fraction of grain in beef cattle feed | not used | 8.000E-01 | --- | AVFG4 |
| C14 | Fraction of grain in milk cow feed | not used | 2.000E-01 | --- | AVFG5 |
| C14 | DCF correction factor for gaseous forms of C14 | not used | 1.234E+02 | --- | CO2F |
| | | | | | |
| STOR | Storage times of contaminated foodstuffs (days): | | | | |
| STOR | Fruits, non-leafy vegetables, and grain | 1.400E+01 | 1.400E+01 | --- | STOR_T(1) |
| STOR | Leafy vegetables | 1.000E+00 | 1.000E+00 | --- | STOR_T(2) |
| STOR | Milk | 1.000E+00 | 1.000E+00 | --- | STOR_T(3) |
| STOR | Meat and poultry | 2.000E+01 | 2.000E+01 | --- | STOR_T(4) |
| STOR | Fish | 7.000E+00 | 7.000E+00 | --- | STOR_T(5) |
| STOR | Crustacea and mollusks | 7.000E+00 | 7.000E+00 | --- | STOR_T(6) |
| STOR | Well water | 1.000E+00 | 1.000E+00 | --- | STOR_T(7) |
| STOR | Surface water | 1.000E+00 | 1.000E+00 | --- | STOR_T(8) |
| STOR | Livestock fodder | 4.500E+01 | 4.500E+01 | --- | STOR_T(9) |
| | | | | | |
| R021 | Thickness of building foundation (m) | not used | 1.500E-01 | --- | FLOOR1 |
| R021 | Bulk density of building foundation (g/cm**3) | not used | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |

Site-Specific Parameter Summary (continued)

| Me. | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R021 | Total porosity of the building foundation | not used | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | not used | 5.000E-02 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | not used | 3.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | not used | 3.000E-07 | --- | DIFFL |
| R021 | in contaminated zone soil | not used | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | not used | 2.000E+00 | --- | HMIX |
| R021 | Average building air exchange rate (1/hr) | not used | 5.000E-01 | --- | REXG |
| R021 | Height of the building (room) (m) | not used | 2.500E+00 | --- | HRM |
| R021 | Building interior area factor | not used | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | not used | -1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | not used | 2.500E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | not used | 1.500E-01 | --- | EMANA(2) |
| | | | | | |
| TITL | Number of graphical time points | 32 | --- | --- | NPTS |
| TITL | Maximum number of integration points for dose | 17 | --- | --- | LYMAX |
| TITL | Maximum number of integration points for risk | 257 | --- | --- | KYMAX |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation (w/o radon) | active |
| 3 -- plant ingestion | suppressed |
| 4 -- meat ingestion | suppressed |
| 5 -- milk ingestion | suppressed |
| 6 -- aquatic foods | suppressed |
| 7 -- drinking water | suppressed |
| 8 -- soil ingestion | active |
| 9 -- radon | suppressed |
| Find peak pathway doses | active |

| Contaminated Zone Dimensions | | Initial Soil Concentrations, pCi/g | |
|---|---|---|---|
| Area: | 1400000.00 square meters | Pu-239 | 1.210E+01 |
| Thickness: | 0.15 meters | | |
| Cover Depth: | 0.00 meters | | |

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

| t (years): | 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| TDOSE(t): | 7.200E-02 | 7.192E-02 | 7.178E-02 | 7.127E-02 | 6.984E-02 | 6.499E-02 | 5.250E-02 | 2.162E-02 |
| M(t): | 2.880E-03 | 2.877E-03 | 2.871E-03 | 2.851E-03 | 2.794E-03 | 2.600E-03 | 2.100E-03 | 8.648E-04 |

Maximum TDOSE(t): 7.200E-02 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.043E-04 | 0.0014 | 1.278E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.912E-02 | 0.8211 |
| Total | 1.043E-04 | 0.0014 | 1.278E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.912E-02 | 0.8211 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.200E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.200E-02 | 1.0000 |

Su all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.043E-04 | 0.0014 | 1.276E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.906E-02 | 0.8211 |
| Total | 1.043E-04 | 0.0014 | 1.276E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.906E-02 | 0.8211 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.192E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.192E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.041E-04 | 0.0015 | 1.274E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.894E-02 | 0.8211 |
| Total | 1.041E-04 | 0.0015 | 1.274E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.894E-02 | 0.8211 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.178E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.178E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.037E-04 | 0.0015 | 1.265E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.852E-02 | 0.8211 |
| Total | 1.037E-04 | 0.0015 | 1.265E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.852E-02 | 0.8211 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.127E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.127E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| adio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| uclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| u-239 | 1.026E-04 | 0.0015 | 1.239E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.734E-02 | 0.8211 |
| otal | 1.026E-04 | 0.0015 | 1.239E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.734E-02 | 0.8211 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

| adio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| uclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| u-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.984E-02 | 1.0000 |
| otal | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.984E-02 | 1.0000 |

Sur of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 9.862E-05 | 0.0015 | 1.153E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.336E-02 | 0.8210 |
| Total | 9.862E-05 | 0.0015 | 1.153E-02 | 0.1775 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.336E-02 | 0.8210 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.499E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.499E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 8.787E-05 | 0.0017 | 9.316E-03 | 0.1774 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.310E-02 | 0.8209 |
| Total | 8.787E-05 | 0.0017 | 9.316E-03 | 0.1774 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.310E-02 | 0.8209 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.250E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.250E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.499E-05 | 0.0025 | 3.832E-03 | 0.1773 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.773E-02 | 0.8202 |
| Total | 5.499E-05 | 0.0025 | 3.832E-03 | 0.1773 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.773E-02 | 0.8202 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.162E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.162E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways

Parent and Progeny Principal Radionuclide Contributions Indicated

| Parent (i) | Product (j) | Branch Fraction* | DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 5.950E-03 | 5.944E-03 | 5.932E-03 | 5.890E-03 | 5.772E-03 | 5.371E-03 | 4.339E-03 | 1.787E-03 |
| Pu-239 | U-235 | 1.000E+00 | 1.327E-11 | 3.307E-11 | 5.355E-11 | 6.650E-11 | 6.615E-11 | 6.299E-11 | 5.459E-11 | 3.068E-11 |
| Pu-239 | Pa-231 | 1.000E+00 | 2.112E-16 | 1.303E-15 | 5.313E-15 | 2.345E-14 | 6.417E-14 | 1.152E-13 | 1.063E-13 | 4.555E-14 |
| Pu-239 | Ac-227 | 1.000E+00 | 4.270E-18 | 5.719E-17 | 5.247E-16 | 6.720E-15 | 4.005E-14 | 1.035E-13 | 1.024E-13 | 4.914E-14 |
| Pu-239 | ∑DSR(j) | | 5.950E-03 | 5.944E-03 | 5.932E-03 | 5.890E-03 | 5.772E-03 | 5.371E-03 | 4.339E-03 | 1.787E-03 |

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g

Basic Radiation Dose Limit = 25 mrem/yr

| Nuclide (i) | t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| Pu-239 | 4.202E+03 | 4.206E+03 | 4.214E+03 | 4.244E+03 | 4.331E+03 | 4.654E+03 | 5.761E+03 | 1.399E+04 |

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

| Nuclide (i) | Initial pCi/g | tmin (years) | DSR(i,tmin) | G(i,tmin) (pCi/g) | DSR(i,tmax) | G(i,tmax) (pCi/g) |
|---|---|---|---|---|---|---|
| Pu-239 | 1.210E+01 | 0.000E+00 | 5.950E-03 | 4.202E+03 | 5.950E-03 | 4.202E+03 |

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | BRF(i) | DOSE(j,t), mrem/yr t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 7.200E-02 | 7.192E-02 | 7.178E-02 | 7.127E-02 | 6.984E-02 | 6.499E-02 | 5.250E-02 | 2.162E-02 |
| U-235 | Pu-239 | 1.000E+00 | 1.605E-10 | 4.001E-10 | 6.480E-10 | 8.047E-10 | 8.004E-10 | 7.622E-10 | 6.605E-10 | 3.712E-10 |
| Pa-231 | Pu-239 | 1.000E+00 | 2.555E-15 | 1.577E-14 | 6.428E-14 | 2.838E-13 | 7.764E-13 | 1.394E-12 | 1.286E-12 | 5.512E-13 |
| Ac-227 | Pu-239 | 1.000E+00 | 5.167E-17 | 6.920E-16 | 6.349E-15 | 8.131E-14 | 4.846E-13 | 1.252E-12 | 1.239E-12 | 5.946E-13 |

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | BRF(i) | S(j,t), pCi/g t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 1.210E+01 | 1.209E+01 | 1.208E+01 | 1.204E+01 | 1.192E+01 | 1.150E+01 | 1.038E+01 | 7.251E+00 |
| U-235 | Pu-239 | 1.000E+00 | 0.000E+00 | 9.571E-09 | 1.948E-08 | 2.580E-08 | 2.582E-08 | 2.491E-08 | 2.248E-08 | 1.571E-08 |
| Pa-231 | Pu-239 | 1.000E+00 | 0.000E+00 | 1.081E-13 | 7.369E-13 | 3.948E-12 | 1.139E-11 | 2.139E-11 | 2.191E-11 | 1.533E-11 |
| Ac-227 | Pu-239 | 1.000E+00 | 0.000E+00 | 1.166E-15 | 2.433E-14 | 4.274E-13 | 2.778E-12 | 7.512E-12 | 8.058E-12 | 5.642E-12 |

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.81 seconds

# RESRAD OUTPUT

# WILDLIFE REFUGE VISITOR – CHILD – TIER 1

Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown EU
File : WBWRVC.RAD

Table of Contents

## t I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: 06957644.LIB

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Ac-227+D | 6.720E+00 | 6.720E+00 | DCF2( 1) |
| B-1 | Pa-231 | 1.280E+00 | 1.280E+00 | DCF2( 2) |
| B-1 | Pu-239 | 2.900E-01 | 4.290E-01 | DCF2( 3) |
| B-1 | U-235+D | 3.550E-02 | 1.230E-01 | DCF2( 4) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Ac-227+D | 1.480E-02 | 1.480E-02 | DCF3( 1) |
| D-1 | Pa-231 | 1.060E-02 | 1.060E-02 | DCF3( 2) |
| D-1 | Pu-239 | 1.600E-03 | 3.540E-03 | DCF3( 3) |
| D-1 | U-235+D | 4.750E-04 | 2.670E-04 | DCF3( 4) |
| | | | | |
| D-34 | Food transfer factors: | | | |
| D-34 | Ac-227+D , plant/soil concentration ratio, dimensionless | 2.500E-03 | 2.500E-03 | RTF( 1,1) |
| D-34 | Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-05 | 2.000E-05 | RTF( 1,2) |
| D-34 | Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-05 | 2.000E-05 | RTF( 1,3) |
| D-34 | | | | |
| D-34 | Pa-231 , plant/soil concentration ratio, dimensionless | 1.000E-02 | 1.000E-02 | RTF( 2,1) |
| D-34 | Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 2,2) |
| D-34 | Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 5.000E-06 | 5.000E-06 | RTF( 2,3) |
| D-34 | | | | |
| D-34 | Pu-239 , plant/soil concentration ratio, dimensionless | 5.800E-05 | 1.000E-03 | RTF( 3,1) |
| D-34 | Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 1.000E-04 | 1.000E-04 | RTF( 3,2) |
| D-34 | Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 1.000E-06 | 1.000E-06 | RTF( 3,3) |
| D-34 | | | | |
| D-34 | U-235+D , plant/soil concentration ratio, dimensionless | 6.000E-03 | 2.500E-03 | RTF( 4,1) |
| D-34 | U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.400E-04 | 3.400E-04 | RTF( 4,2) |
| D-34 | U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 6.000E-04 | 6.000E-04 | RTF( 4,3) |
| | | | | |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Ac-227+D , fish | 1.500E+01 | 1.500E+01 | BIOFAC( 1,1) |
| D-5 | Ac-227+D , crustacea and mollusks | 1.000E+03 | 1.000E+03 | BIOFAC( 1,2) |
| D-5 | | | | |
| D-5 | Pa-231 , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 2,1) |
| D-5 | Pa-231 , crustacea and mollusks | 1.100E+02 | 1.100E+02 | BIOFAC( 2,2) |
| D-5 | | | | |
| D-5 | Pu-239 , fish | 3.000E+01 | 3.000E+01 | BIOFAC( 3,1) |
| D-5 | Pu-239 , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 3,2) |
| D-5 | | | | |
| D-5 | U-235+D , fish | 1.000E+01 | 1.000E+01 | BIOFAC( 4,1) |
| D-5 | U-235+D , crustacea and mollusks | 6.000E+01 | 6.000E+01 | BIOFAC( 4,2) |

Site-Specific Parameter Summary

| Me... | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 1.400E+06 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 1.500E-01 | 2.000E+00 | --- | THICK0 |
| R011 | Length parallel to aquifer flow (m) | not used | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 2.500E+01 | 2.500E+01 | --- | BRDL |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 3.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 3.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 3.000E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 1.000E+03 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T( 9) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T(10) |
| | | | | | |
| R012 | Initial principal radionuclide (pCi/g): Pu-239 | 1.210E+01 | 0.000E+00 | --- | S1( 3) |
| R012 | Concentration in groundwater (pCi/L): Pu-239 | not used | 0.000E+00 | --- | W1( 3) |
| | | | | | |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.500E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.700E+00 | 1.500E+00 | --- | DENSCZ |
| R01? | Contaminated zone erosion rate (m/yr) | 7.490E-05 | 1.000E-03 | --- | VCZ |
| RC | Contaminated zone total porosity | 3.000E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone field capacity | 1.000E-01 | 2.000E-01 | --- | FCCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 4.450E+01 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 1.040E+01 | 5.300E+00 | --- | BCZ |
| R013 | Average annual wind speed (m/sec) | 4.200E+00 | 2.000E+00 | --- | WIND |
| R013 | Humidity in air (g/m**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 2.530E-01 | 5.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 3.810E-01 | 1.000E+00 | --- | PRECIP |
| R013 | Irrigation (m/yr) | 0.000E+00 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 4.000E-03 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | not used | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | not used | 1.000E-03 | --- | EPS |
| | | | | | |
| R014 | Density of saturated zone (g/cm**3) | not used | 1.500E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | not used | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | not used | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone field capacity | not used | 2.000E-01 | --- | FCSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | not used | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | not used | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | not used | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | not used | 1.000E-03 | --- | VWT |
| R014 | Well pump intake depth (m below water table) | not used | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | not used | ND | --- | MODEL |
| R014 | Well pumping rate (m**3/yr) | not used | 2.500E+02 | --- | UW |
| | | | | | |
| R01? | Number of unsaturated zone strata | not used | 1 | --- | NS |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R015 | Unsat. zone 1, thickness (m) | not used | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | not used | 1.500E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | not used | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | not used | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, field capacity | not used | 2.000E-01 | --- | FCUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | not used | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | not used | 1.000E+01 | --- | HCUZ(1) |
| | | | | | |
| R016 | Distribution coefficients for Pu-239 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.300E+03 | 2.000E+03 | --- | DCNUCC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 2.000E+03 | --- | DCNUCU( 3,1) |
| R016 | Saturated zone (cm**3/g) | not used | 2.000E+03 | --- | DCNUCS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.833E-04 | ALEACH( 3) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 3) |
| | | | | | |
| R016 | Distribution coefficients for daughter Ac-227 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.000E+01 | 2.000E+01 | --- | DCNUCC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 2.000E+01 | --- | DCNUCU( 1,1) |
| R016 | Saturated zone (cm**3/g) | not used | 2.000E+01 | --- | DCNUCS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 5.519E-02 | ALEACH( 1) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 1) |
| | | | | | |
| R016 | Distribution coefficients for daughter Pa-231 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 5.000E+01 | --- | DCNUCC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 5.000E+01 | --- | DCNUCU( 2,1) |
| R016 | Saturated zone (cm**3/g) | not used | 5.000E+01 | --- | DCNUCS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 2.217E-02 | ALEACH( 2) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 2) |
| | | | | | |
| R016 | Distribution coefficients for daughter U-235 | | | | |
| R016 | Contaminated zone (cm**3/g) | 2.300E+00 | 5.000E+01 | --- | DCNUCC( 4) |
| R016 | Unsaturated zone 1 (cm**3/g) | not used | 5.000E+01 | --- | DCNUCU( 4,1) |
| R016 | Saturated zone (cm**3/g) | not used | 5.000E+01 | --- | DCNUCS( 4) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 4.551E-01 | ALEACH( 4) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 4) |
| | | | | | |
| R017 | Inhalation rate (m**3/yr) | 1.400E+04 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 6.700E-05 | 1.000E-04 | --- | MLINH |
| R017 | Exposure duration | 3.000E+01 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 7.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 4.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 0.000E+00 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 3.000E-02 | 2.500E-01 | --- | FOTD |
| R017 | Shape factor flag, external gamma | 1.000E+00 | 1.000E+00 | >0 shows circular AREA. | FS |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R017 | Radii of shape factor array (used if FS = -1): | | | | |
| R017 | Outer annular radius (m), ring 1: | not used | 5.000E+01 | --- | RAD_SHAPE( 1) |
| R017 | Outer annular radius (m), ring 2: | not used | 7.071E+01 | --- | RAD_SHAPE( 2) |
| R017 | Outer annular radius (m), ring 3: | not used | 0.000E+00 | --- | RAD_SHAPE( 3) |
| R017 | Outer annular radius (m), ring 4: | not used | 0.000E+00 | --- | RAD_SHAPE( 4) |
| R017 | Outer annular radius (m), ring 5: | not used | 0.000E+00 | --- | RAD_SHAPE( 5) |
| R017 | Outer annular radius (m), ring 6: | not used | 0.000E+00 | --- | RAD_SHAPE( 6) |
| R017 | Outer annular radius (m), ring 7: | not used | 0.000E+00 | --- | RAD_SHAPE( 7) |
| R017 | Outer annular radius (m), ring 8: | not used | 0.000E+00 | --- | RAD_SHAPE( 8) |
| R017 | Outer annular radius (m), ring 9: | not used | 0.000E+00 | --- | RAD_SHAPE( 9) |
| R017 | Outer annular radius (m), ring 10: | not used | 0.000E+00 | --- | RAD_SHAPE(10) |
| R017 | Outer annular radius (m), ring 11: | not used | 0.000E+00 | --- | RAD_SHAPE(11) |
| R017 | Outer annular radius (m), ring 12: | not used | 0.000E+00 | --- | RAD_SHAPE(12) |
| | | | | | |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Ring 1 | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Ring 2 | not used | 2.732E-01 | --- | FRACA( 2) |
| R017 | Ring 3 | not used | 0.000E+00 | --- | FRACA( 3) |
| R017 | Ring 4 | not used | 0.000E+00 | --- | FRACA( 4) |
| R017 | Ring 5 | not used | 0.000E+00 | --- | FRACA( 5) |
| R017 | Ring 6 | not used | 0.000E+00 | --- | FRACA( 6) |
| R017 | Ring 7 | not used | 0.000E+00 | --- | FRACA( 7) |
| R0 | Ring 8 | not used | 0.000E+00 | --- | FRACA( 8) |
| R0 | Ring 9 | not used | 0.000E+00 | --- | FRACA( 9) |
| R017 | Ring 10 | not used | 0.000E+00 | --- | FRACA(10) |
| R017 | Ring 11 | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Ring 12 | not used | 0.000E+00 | --- | FRACA(12) |
| | | | | | |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | not used | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | not used | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | not used | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | not used | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | not used | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | not used | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 3.504E+02 | 3.650E+01 | --- | SOIL |
| R018 | Drinking water intake (L/yr) | not used | 5.100E+02 | --- | DWI |
| R018 | Contamination fraction of drinking water | not used | 1.000E+00 | --- | FDW |
| R018 | Contamination fraction of household water | not used | 1.000E+00 | --- | FHHW |
| R018 | Contamination fraction of livestock water | not used | 1.000E+00 | --- | FLW |
| R018 | Contamination fraction of irrigation water | not used | 1.000E+00 | --- | FIRW |
| R018 | Contamination fraction of aquatic food | not used | 5.000E-01 | --- | FR9 |
| R018 | Contamination fraction of plant food | not used | -1 | --- | FPLANT |
| R018 | Contamination fraction of meat | not used | -1 | --- | FMEAT |
| R018 | Contamination fraction of milk | not used | -1 | --- | FMILK |
| | | | | | |
| R019 | Livestock fodder intake for meat (kg/day) | not used | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | not used | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | not used | 5.000E+01 | --- | LWI5 |
| R | Livestock water intake for milk (L/day) | not used | 1.600E+02 | --- | LWI6 |
| R019 | Livestock soil intake (kg/day) | not used | 5.000E-01 | --- | LSI |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R019 | Mass loading for foliar deposition (g/m**3) | not used | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | not used | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | not used | 1.000E+00 | --- | FGWDW |
| R019 | Household water fraction from ground water | not used | 1.000E+00 | --- | FGWHH |
| R019 | Livestock water fraction from ground water | not used | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | not used | 1.000E+00 | --- | FGWIR |
| | | | | | |
| R19B | Wet weight crop yield for Non-Leafy (kg/m**2) | not used | 7.000E-01 | --- | YV(1) |
| R19B | Wet weight crop yield for Leafy (kg/m**2) | not used | 1.500E+00 | --- | YV(2) |
| R19B | Wet weight crop yield for Fodder (kg/m**2) | not used | 1.100E+00 | --- | YV(3) |
| R19B | Growing Season for Non-Leafy (years) | not used | 1.700E-01 | --- | TE(1) |
| R19B | Growing Season for Leafy (years) | not used | 2.500E-01 | --- | TE(2) |
| R19B | Growing Season for Fodder (years) | not used | 8.000E-02 | --- | TE(3) |
| R19B | Translocation Factor for Non-Leafy | not used | 1.000E-01 | --- | TIV(1) |
| R19B | Translocation Factor for Leafy | not used | 1.000E+00 | --- | TIV(2) |
| R19B | Translocation Factor for Fodder | not used | 1.000E+00 | --- | TIV(3) |
| R19B | Dry Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RDRY(1) |
| R19B | Dry Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RDRY(2) |
| R19B | Dry Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RDRY(3) |
| R19B | Wet Foliar Interception Fraction for Non-Leafy | not used | 2.500E-01 | --- | RWET(1) |
| R19B | Wet Foliar Interception Fraction for Leafy | not used | 2.500E-01 | --- | RWET(2) |
| R19B | Wet Foliar Interception Fraction for Fodder | not used | 2.500E-01 | --- | RWET(3) |
| R19B | Weathering Removal Constant for Vegetation | not used | 2.000E+01 | --- | WLAM |
| | | | | | |
| C14 | C-12 concentration in water (g/cm**3) | not used | 2.000E-05 | --- | C12WTR |
| C14 | C-12 concentration in contaminated soil (g/g) | not used | 3.000E-02 | --- | C12CZ |
| C14 | Fraction of vegetation carbon from soil | not used | 2.000E-02 | --- | CSOIL |
| C14 | Fraction of vegetation carbon from air | not used | 9.800E-01 | --- | CAIR |
| C14 | C-14 evasion layer thickness in soil (m) | not used | 3.000E-01 | --- | DMC |
| C14 | C-14 evasion flux rate from soil (1/sec) | not used | 7.000E-07 | --- | EVSN |
| C14 | C-12 evasion flux rate from soil (1/sec) | not used | 1.000E-10 | --- | REVSN |
| C14 | Fraction of grain in beef cattle feed | not used | 8.000E-01 | --- | AVFG4 |
| C14 | Fraction of grain in milk cow feed | not used | 2.000E-01 | --- | AVFG5 |
| C14 | DCF correction factor for gaseous forms of C14 | not used | 1.234E+02 | --- | CO2F |
| | | | | | |
| STOR | Storage times of contaminated foodstuffs (days): | | | | |
| STOR | Fruits, non-leafy vegetables, and grain | 1.400E+01 | 1.400E+01 | --- | STOR_T(1) |
| STOR | Leafy vegetables | 1.000E+00 | 1.000E+00 | --- | STOR_T(2) |
| STOR | Milk | 1.000E+00 | 1.000E+00 | --- | STOR_T(3) |
| STOR | Meat and poultry | 2.000E+01 | 2.000E+01 | --- | STOR_T(4) |
| STOR | Fish | 7.000E+00 | 7.000E+00 | --- | STOR_T(5) |
| STOR | Crustacea and mollusks | 7.000E+00 | 7.000E+00 | --- | STOR_T(6) |
| STOR | Well water | 1.000E+00 | 1.000E+00 | --- | STOR_T(7) |
| STOR | Surface water | 1.000E+00 | 1.000E+00 | --- | STOR_T(8) |
| STOR | Livestock fodder | 4.500E+01 | 4.500E+01 | --- | STOR_T(9) |
| | | | | | |
| R021 | Thickness of building foundation (m) | not used | 1.500E-01 | --- | FLOOR1 |
| R021 | Bulk density of building foundation (g/cm**3) | not used | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R021 | Total porosity of the building foundation | not used | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | not used | 5.000E-02 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | not used | 3.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | not used | 3.000E-07 | --- | DIFFL |
| R021 | in contaminated zone soil | not used | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | not used | 2.000E+00 | --- | HMIX |
| R021 | Average building air exchange rate (1/hr) | not used | 5.000E-01 | --- | REXG |
| R021 | Height of the building (room) (m) | not used | 2.500E+00 | --- | HRM |
| R021 | Building interior area factor | not used | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | not used | -1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | not used | 2.500E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | not used | 1.500E-01 | --- | EMANA(2) |
| | | | | | |
| TITL | Number of graphical time points | 32 | --- | --- | NPTS |
| TITL | Maximum number of integration points for dose | 17 | --- | --- | LYMAX |
| TITL | Maximum number of integration points for risk | 257 | --- | --- | KYMAX |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation (w/o radon) | active |
| 3 -- plant ingestion | suppressed |
| 4 -- meat ingestion | suppressed |
| 5 -- milk ingestion | suppressed |
| 6 -- aquatic foods | suppressed |
| 7 -- drinking water | suppressed |
| 8 -- soil ingestion | active |
| 9 -- radon | suppressed |
| Find peak pathway doses | active |

| Contaminated Zone Dimensions | | Initial Soil Concentrations, pCi/g | |
|---|---|---|---|
| Area: | 1400000.00 square meters | Pu-239 | 1.210E+01 |
| Thickness: | 0.15 meters | | |
| Cover Depth: | 0.00 meters | | |

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

| t (years): | 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| TDOSE(t): | 2.172E-01 | 2.169E-01 | 2.165E-01 | 2.150E-01 | 2.107E-01 | 1.960E-01 | 1.583E-01 | 6.516E-02 |
| M(t): | 8.687E-03 | 8.678E-03 | 8.660E-03 | 8.599E-03 | 8.426E-03 | 7.841E-03 | 6.334E-03 | 2.606E-03 |

Maximum TDOSE(t): 2.172E-01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | 1.043E-04 | 0.0005 | 1.365E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.034E-01 | 0.9367 |
| Total | 1.043E-04 | 0.0005 | 1.365E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.034E-01 | 0.9367 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

| Radio-Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.172E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.172E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.043E-04 | 0.0005 | 1.364E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.032E-01 | 0.9367 |
| Total | 1.043E-04 | 0.0005 | 1.364E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.032E-01 | 0.9367 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.169E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.169E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.041E-04 | 0.0005 | 1.361E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.028E-01 | 0.9367 |
| Total | 1.041E-04 | 0.0005 | 1.361E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.028E-01 | 0.9367 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.165E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.165E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.037E-04 | 0.0005 | 1.351E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.014E-01 | 0.9367 |
| Total | 1.037E-04 | 0.0005 | 1.351E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.014E-01 | 0.9367 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.150E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.150E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 1.026E-04 | 0.0005 | 1.324E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.973E-01 | 0.9367 |
| Total | 1.026E-04 | 0.0005 | 1.324E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.973E-01 | 0.9367 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.107E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.107E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 9.862E-05 | 0.0005 | 1.232E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.836E-01 | 0.9366 |
| Total | 9.862E-05 | 0.0005 | 1.232E-02 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.836E-01 | 0.9366 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.960E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.960E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 8.787E-05 | 0.0006 | 9.953E-03 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.483E-01 | 0.9366 |
| Total | 8.787E-05 | 0.0006 | 9.953E-03 | 0.0629 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.483E-01 | 0.9366 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.583E-01 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.583E-01 | 1.0000 |

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 5.499E-05 | 0.0008 | 4.095E-03 | 0.0628 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.101E-02 | 0.9363 |
| Total | 5.499E-05 | 0.0008 | 4.095E-03 | 0.0628 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.101E-02 | 0.9363 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Pu-239 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.516E-02 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.516E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

| Parent (i) | Product (j) | Branch Fraction* | DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 1.795E-02 | 1.793E-02 | 1.789E-02 | 1.777E-02 | 1.741E-02 | 1.620E-02 | 1.309E-02 | 5.385E-03 |
| Pu-239 | U-235 | 1.000E+00 | 1.158E-11 | 2.886E-11 | 4.674E-11 | 5.807E-11 | 5.781E-11 | 5.523E-11 | 4.832E-11 | 2.810E-11 |
| Pu-239 | Pa-231 | 1.000E+00 | 3.768E-16 | 2.326E-15 | 9.480E-15 | 4.185E-14 | 1.145E-13 | 2.053E-13 | 1.887E-13 | 7.952E-14 |
| Pu-239 | Ac-227 | 1.000E+00 | 5.917E-18 | 7.925E-17 | 7.269E-16 | 9.308E-15 | 5.543E-14 | 1.428E-13 | 1.400E-13 | 6.467E-14 |
| Pu-239 | ∑DSR(j) | | 1.795E-02 | 1.793E-02 | 1.789E-02 | 1.777E-02 | 1.741E-02 | 1.620E-02 | 1.309E-02 | 5.385E-03 |

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit =  25 mrem/yr

| Nuclide (i) | t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|
| Pu-239 | 1.393E+03 | 1.394E+03 | 1.397E+03 | 1.407E+03 | 1.436E+03 | 1.543E+03 | 1.910E+03 | 4.642E+03 |

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

| Nuclide (i) | Initial pCi/g | tmin (years) | DSR(i,tmin) | G(i,tmin) (pCi/g) | DSR(i,tmax) | G(i,tmax) (pCi/g) |
|---|---|---|---|---|---|---|
| Pu-239 | 1.210E+01 | 0.000E+00 | 1.795E-02 | 1.393E+03 | 1.795E-02 | 1.393E+03 |

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | BRF(i) | DOSE(j,t), mrem/yr t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 2.172E-01 | 2.169E-01 | 2.165E-01 | 2.150E-01 | 2.107E-01 | 1.960E-01 | 1.583E-01 | 6.516E-02 |
| U-235 | Pu-239 | 1.000E+00 | 1.401E-10 | 3.492E-10 | 5.656E-10 | 7.026E-10 | 6.995E-10 | 6.683E-10 | 5.846E-10 | 3.400E-10 |
| Pa-231 | Pu-239 | 1.000E+00 | 4.560E-15 | 2.815E-14 | 1.147E-13 | 5.064E-13 | 1.385E-12 | 2.484E-12 | 2.283E-12 | 9.622E-13 |
| Ac-227 | Pu-239 | 1.000E+00 | 7.160E-17 | 9.589E-16 | 8.796E-15 | 1.126E-13 | 6.707E-13 | 1.728E-12 | 1.695E-12 | 7.826E-13 |

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

| Nuclide (j) | Parent (i) | BRF(i) | S(j,t), pCi/g t= 0.000E+00 | 1.000E+00 | 3.000E+00 | 1.000E+01 | 3.000E+01 | 1.000E+02 | 3.000E+02 | 1.000E+03 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pu-239 | Pu-239 | 1.000E+00 | 1.210E+01 | 1.209E+01 | 1.208E+01 | 1.204E+01 | 1.192E+01 | 1.150E+01 | 1.038E+01 | 7.251E+00 |
| U-235 | Pu-239 | 1.000E+00 | 0.000E+00 | 9.571E-09 | 1.948E-08 | 2.580E-08 | 2.582E-08 | 2.491E-08 | 2.248E-08 | 1.571E-08 |
| Pa-231 | Pu-239 | 1.000E+00 | 0.000E+00 | 1.081E-13 | 7.369E-13 | 3.948E-12 | 1.139E-11 | 2.139E-11 | 2.191E-11 | 1.533E-11 |
| Ac-227 | Pu-239 | 1.000E+00 | 0.000E+00 | 1.166E-15 | 2.433E-14 | 4.274E-13 | 2.778E-12 | 7.512E-12 | 8.058E-12 | 5.642E-12 |

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.82 seconds

**RESRAD OUTPUT**

**WILDLIFE REFUGE WORKER – TIER 2**

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1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page   1
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

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 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                           Dose Conversion Factor (and Related) Parameter Summary
                                                    File: 77001589.LIB
0      ³                                                          ³  Current  ³
        ³  Parameter
 Menu ³                          Parameter                        ³   Value   ³
Default  ³    Name

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 B-1  ³ Dose conversion factors for inhalation, mrem/pCi:        ³           ³
        ³
 B-1  ³ Ac-227+D                                                  ³ 6.720E+00 ³
6.720E+00 ³ DCF2( 1)
 B-1  ³ Pa-231                                                    ³ 1.280E+00 ³
1.280E+00 ³ DCF2( 2)
 B-1  ³ Pu-239                                                    ³ 1.900E-01 ³
4.290E-01 ³ DCF2( 3)
 B-1  ³ U-235+D                                                   ³ 1.230E-01 ³
1.230E-01 ³ DCF2( 4)
      ³                                                           ³           ³
        ³
 D-1  ³ Dose conversion factors for ingestion, mrem/pCi:         ³           ³
        ³
 D-1  ³ Ac-227+D                                                  ³ 1.480E-02 ³
1.480E-02 ³ DCF3( 1)
 D-1  ³ Pa-231                                                    ³ 1.060E-02 ³
1.060E-02 ³ DCF3( 2)
 D-1  ³ Pu-239                                                    ³ 9.300E-04 ³
3.540E-03 ³ DCF3( 3)
 D-1  ³ U-235+D                                                   ³ 2.670E-04 ³
2.670E-04 ³ DCF3( 4)
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      ³                                                         ³          ³
       ³
 D-34 ³ Food transfer factors:                                   ³          ³
       ³
 D-34 ³ Ac-227+D , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³
2.500E-03 ³ RTF( 1,1)
 D-34 ³ Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 2.000E-05 ³
2.000E-05 ³ RTF( 1,2)
 D-34 ³ Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 2.000E-05 ³
2.000E-05 ³ RTF( 1,3)
 D-34 ³                                                          ³          ³
       ³
 D-34 ³ Pa-231   , plant/soil concentration ratio, dimensionless    ³ 1.000E-02 ³
1.000E-02 ³ RTF( 2,1)
 D-34 ³ Pa-231   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 5.000E-03 ³
5.000E-03 ³ RTF( 2,2)
 D-34 ³ Pa-231   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 5.000E-06 ³
5.000E-06 ³ RTF( 2,3)
 D-34 ³                                                          ³          ³
       ³
 D-34 ³ Pu-239   , plant/soil concentration ratio, dimensionless    ³ 5.800E-05 ³
1.000E-03 ³ RTF( 3,1)
 D-34 ³ Pu-239   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 1.000E-04 ³
1.000E-04 ³ RTF( 3,2)
 D-34 ³ Pu-239   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 1.000E-06 ³
1.000E-06 ³ RTF( 3,3)
 D-34 ³                                                          ³          ³
       ³
 D-34 ³ U-235+D  , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³
2.500E-03 ³ RTF( 4,1)
 D-34 ³ U-235+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 3.400E-04 ³
3.400E-04 ³ RTF( 4,2)
 D-34 ³ U-235+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 6.000E-04 ³
6.000E-04 ³ RTF( 4,3)
      ³                                                         ³          ³
       ³
 D-5  ³ Bioaccumulation factors, fresh water, L/kg:              ³          ³
       ³
 D-5  ³ Ac-227+D , fish                                          ³ 1.500E+01 ³
1.500E+01 ³ BIOFAC( 1,1)
 D-5  ³ Ac-227+D , crustacea and mollusks                        ³ 1.000E+03 ³
1.000E+03 ³ BIOFAC( 1,2)
 D-5  ³                                                          ³          ³
       ³
 D-5  ³ Pa-231   , fish                                          ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC( 2,1)
 D-5  ³ Pa-231   , crustacea and mollusks                        ³ 1.100E+02 ³
1.100E+02 ³ BIOFAC( 2,2)
 D-5  ³                                                          ³          ³
       ³
 D-5  ³ Pu-239   , fish                                          ³ 3.000E+01 ³
3.000E+01 ³ BIOFAC( 3,1)
 D-5  ³ Pu-239   , crustacea and mollusks                        ³ 1.000E+02 ³
1.000E+02 ³ BIOFAC( 3,2)
 D-5  ³                                                          ³          ³
       ³
 D-5  ³ U-235+D  , fish                                          ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC( 4,1)
 D-5  ³ U-235+D  , crustacea and mollusks                        ³ 6.000E+01 ³
6.000E+01 ³ BIOFAC( 4,2)

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 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                                                          Site-Specific Parameter Summary
0     ³                                                  ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                    Parameter                     ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R011 ³ Area of contaminated zone (m**2)                 ³ 1.400E+06 ³ 1.000E+04 ³
          ---                ³ AREA
 R011 ³ Thickness of contaminated zone (m)               ³ 1.500E-01 ³ 2.000E+00 ³
          ---                ³ THICK0
 R011 ³ Length parallel to aquifer flow (m)              ³ not used  ³ 1.000E+02 ³
          ---                ³ LCZPAQ
 R011 ³ Basic radiation dose limit (mrem/yr)             ³ 2.500E+01 ³ 2.500E+01 ³
          ---                ³ BRDL
 R011 ³ Time since placement of material (yr)            ³ 0.000E+00 ³ 0.000E+00 ³
          ---                ³ TI
 R011 ³ Times for calculations (yr)                      ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ T( 2)
 R011 ³ Times for calculations (yr)                      ³ 3.000E+00 ³ 3.000E+00 ³
          ---                ³ T( 3)
 R011 ³ Times for calculations (yr)                      ³ 1.000E+01 ³ 1.000E+01 ³
          ---                ³ T( 4)
 R011 ³ Times for calculations (yr)                      ³ 3.000E+01 ³ 3.000E+01 ³
          ---                ³ T( 5)
 R011 ³ Times for calculations (yr)                      ³ 1.000E+02 ³ 1.000E+02 ³
          ---                ³ T( 6)
 R011 ³ Times for calculations (yr)                      ³ 3.000E+02 ³ 3.000E+02 ³
          ---                ³ T( 7)
 R011 ³ Times for calculations (yr)                      ³ 1.000E+03 ³ 1.000E+03 ³
          ---                ³ T( 8)
 R011 ³ Times for calculations (yr)                      ³ not used  ³ 0.000E+00 ³
          ---                ³ T( 9)
 R011 ³ Times for calculations (yr)                      ³ not used  ³ 0.000E+00 ³
          ---                ³ T(10)
      ³                                                  ³           ³           ³
                             ³
 R012 ³ Initial principal radionuclide (pCi/g):  Pu-239  ³ 7.700E+00 ³ 0.000E+00 ³
          ---                ³ S1( 3)
 R012 ³ Concentration in groundwater   (pCi/L):  Pu-239  ³ not used  ³ 0.000E+00 ³
          ---                ³ W1( 3)
      ³                                                  ³           ³           ³
                             ³
 R013 ³ Cover depth (m)                                  ³ 0.000E+00 ³ 0.000E+00 ³
          ---                ³ COVER0
 R013 ³ Density of cover material (g/cm**3)              ³ not used  ³ 1.500E+00 ³
          ---                ³ DENSCV
 R013 ³ Cover depth erosion rate (m/yr)                  ³ not used  ³ 1.000E-03 ³
          ---                ³ VCV
 R013 ³ Density of contaminated zone (g/cm**3)           ³ 1.700E+00 ³ 1.500E+00 ³
          ---                ³ DENSCZ
 R013 ³ Contaminated zone erosion rate (m/yr)            ³ 7.490E-05 ³ 1.000E-03 ³
          ---                ³ VCZ
 R013 ³ Contaminated zone total porosity                 ³ 3.000E-01 ³ 4.000E-01 ³
          ---                ³ TPCZ
 R013 ³ Contaminated zone field capacity                 ³ 1.000E-01 ³ 2.000E-01 ³
          ---                ³ FCCZ
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 R013 ³ Contaminated zone hydraulic conductivity (m/yr)  ³ 4.450E+01 ³ 1.000E+01 ³
          ---                ³ HCCZ
 R013 ³ Contaminated zone b parameter                    ³ 1.040E+01 ³ 5.300E+00 ³
          ---                ³ BCZ
 R013 ³ Average annual wind speed (m/sec)                ³ 4.200E+00 ³ 2.000E+00 ³
          ---                ³ WIND
 R013 ³ Humidity in air (g/m**3)                         ³ not used  ³ 8.000E+00 ³
          ---                ³ HUMID
 R013 ³ Evapotranspiration coefficient                   ³ 2.530E-01 ³ 5.000E-01 ³
          ---                ³ EVAPTR
 R013 ³ Precipitation (m/yr)                             ³ 3.810E-01 ³ 1.000E+00 ³
          ---                ³ PRECIP
 R013 ³ Irrigation (m/yr)                                ³ 0.000E+00 ³ 2.000E-01 ³
          ---                ³ RI
 R013 ³ Irrigation mode                                  ³ overhead  ³ overhead  ³
          ---                ³ IDITCH
 R013 ³ Runoff coefficient                               ³ 4.000E-03 ³ 2.000E-01 ³
          ---                ³ RUNOFF
 R013 ³ Watershed area for nearby stream or pond (m**2)  ³ not used  ³ 1.000E+06 ³
          ---                ³ WAREA
 R013 ³ Accuracy for water/soil computations             ³ not used  ³ 1.000E-03 ³
          ---                ³ EPS
      ³                                                  ³           ³           ³
                             ³
 R014 ³ Density of saturated zone (g/cm**3)              ³ not used  ³ 1.500E+00 ³
          ---                ³ DENSAQ
 R014 ³ Saturated zone total porosity                    ³ not used  ³ 4.000E-01 ³
          ---                ³ TPSZ
 R014 ³ Saturated zone effective porosity                ³ not used  ³ 2.000E-01 ³
          ---                ³ EPSZ
 R014 ³ Saturated zone field capacity                    ³ not used  ³ 2.000E-01 ³
          ---                ³ FCSZ
 R014 ³ Saturated zone hydraulic conductivity (m/yr)     ³ not used  ³ 1.000E+02 ³
          ---                ³ HCSZ
 R014 ³ Saturated zone hydraulic gradient                ³ not used  ³ 2.000E-02 ³
          ---                ³ HGWT
 R014 ³ Saturated zone b parameter                       ³ not used  ³ 5.300E+00 ³
          ---                ³ BSZ
 R014 ³ Water table drop rate (m/yr)                     ³ not used  ³ 1.000E-03 ³
          ---                ³ VWT
 R014 ³ Well pump intake depth (m below water table)     ³ not used  ³ 1.000E+01 ³
          ---                ³ DWIBWT
 R014 ³ Model: Nondispersion (ND) or Mass-Balance (MB)   ³ not used  ³ ND        ³
          ---                ³ MODEL
 R014 ³ Well pumping rate (m**3/yr)                      ³ not used  ³ 2.500E+02 ³
          ---                ³ UW
      ³                                                  ³           ³           ³
                             ³
 R015 ³ Number of unsaturated zone strata                ³ not used  ³ 1         ³
          ---                ³ NS
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                                           Site-Specific Parameter Summary
(continued)
0     ³                                                  ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                 Parameter                        ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R015 ³ Unsat. zone 1, thickness (m)                   ³ not used  ³ 4.000E+00 ³
        ---                ³ H(1)
 R015 ³ Unsat. zone 1, soil density (g/cm**3)          ³ not used  ³ 1.500E+00 ³
        ---                ³ DENSUZ(1)
 R015 ³ Unsat. zone 1, total porosity                  ³ not used  ³ 4.000E-01 ³
        ---                ³ TPUZ(1)
 R015 ³ Unsat. zone 1, effective porosity              ³ not used  ³ 2.000E-01 ³
        ---                ³ EPUZ(1)
 R015 ³ Unsat. zone 1, field capacity                  ³ not used  ³ 2.000E-01 ³
        ---                ³ FCUZ(1)
 R015 ³ Unsat. zone 1, soil-specific b parameter       ³ not used  ³ 5.300E+00 ³
        ---                ³ BUZ(1)
 R015 ³ Unsat. zone 1, hydraulic conductivity (m/yr)   ³ not used  ³ 1.000E+01 ³
        ---                ³ HCUZ(1)
      ³                                                ³           ³           ³
                           ³
 R016 ³ Distribution coefficients for Pu-239           ³           ³           ³
                           ³
 R016 ³   Contaminated zone (cm**3/g)                  ³ 2.300E+03 ³ 2.000E+03 ³
        ---                ³ DCNUCC( 3)
 R016 ³   Unsaturated zone 1 (cm**3/g)                 ³ not used  ³ 2.000E+03 ³
        ---                ³ DCNUCU( 3,1)
 R016 ³   Saturated zone (cm**3/g)                     ³ not used  ³ 2.000E+03 ³
        ---                ³ DCNUCS( 3)
 R016 ³   Leach rate (/yr)                             ³ 0.000E+00 ³ 0.000E+00 ³
        4.833E-04          ³ ALEACH( 3)
 R016 ³   Solubility constant                          ³ 0.000E+00 ³ 0.000E+00 ³
        not used           ³ SOLUBK( 3)
      ³                                                ³           ³           ³
                           ³
 R016 ³ Distribution coefficients for daughter Ac-227  ³           ³           ³
                           ³
 R016 ³   Contaminated zone (cm**3/g)                  ³ 2.000E+01 ³ 2.000E+01 ³
        ---                ³ DCNUCC( 1)
 R016 ³   Unsaturated zone 1 (cm**3/g)                 ³ not used  ³ 2.000E+01 ³
        ---                ³ DCNUCU( 1,1)
 R016 ³   Saturated zone (cm**3/g)                     ³ not used  ³ 2.000E+01 ³
        ---                ³ DCNUCS( 1)
 R016 ³   Leach rate (/yr)                             ³ 0.000E+00 ³ 0.000E+00 ³
        5.519E-02          ³ ALEACH( 1)
 R016 ³   Solubility constant                          ³ 0.000E+00 ³ 0.000E+00 ³
        not used           ³ SOLUBK( 1)
      ³                                                ³           ³           ³
                           ³
 R016 ³ Distribution coefficients for daughter Pa-231  ³           ³           ³
                           ³
 R016 ³   Contaminated zone (cm**3/g)                  ³ 5.000E+01 ³ 5.000E+01 ³
        ---                ³ DCNUCC( 2)
 R016 ³   Unsaturated zone 1 (cm**3/g)                 ³ not used  ³ 5.000E+01 ³
        ---                ³ DCNUCU( 2,1)
 R016 ³   Saturated zone (cm**3/g)                     ³ not used  ³ 5.000E+01 ³
        ---                ³ DCNUCS( 2)
 R016 ³   Leach rate (/yr)                             ³ 0.000E+00 ³ 0.000E+00 ³
        2.217E-02          ³ ALEACH( 2)
 R016 ³   Solubility constant                          ³ 0.000E+00 ³ 0.000E+00 ³
        not used           ³ SOLUBK( 2)
      ³                                                ³           ³           ³
                           ³
 R016 ³ Distribution coefficients for daughter U-235   ³           ³           ³
                           ³
 R016 ³   Contaminated zone (cm**3/g)                  ³ 2.300E+00 ³ 5.000E+01 ³
        ---                ³ DCNUCC( 4)
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 R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ not used  ³ 5.000E+01 ³
        ---                ³ DCNUCU( 4,1)
 R016 ³   Saturated zone (cm**3/g)                      ³ not used  ³ 5.000E+01 ³
        ---                ³ DCNUCS( 4)
 R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³
      4.551E-01            ³ ALEACH( 4)
 R016 ³   Solubility constant                           ³ 0.000E+00 ³ 0.000E+00 ³
      not used             ³ SOLUBK( 4)
      ³                                                 ³           ³           ³
                           ³
 R017 ³ Inhalation rate (m**3/yr)                       ³ 1.400E+04 ³ 8.400E+03 ³
        ---                ³ INHALR
 R017 ³ Mass loading for inhalation (g/m**3)            ³ 6.700E-05 ³ 1.000E-04 ³
        ---                ³ MLINH
 R017 ³ Exposure duration                               ³ 3.000E+01 ³ 3.000E+01 ³
        ---                ³ ED
 R017 ³ Shielding factor, inhalation                    ³ 7.000E-01 ³ 4.000E-01 ³
        ---                ³ SHF3
 R017 ³ Shielding factor, external gamma                ³ 4.000E-01 ³ 7.000E-01 ³
        ---                ³ SHF1
 R017 ³ Fraction of time spent indoors                  ³ 1.140E-01 ³ 5.000E-01 ³
        ---                ³ FIND
 R017 ³ Fraction of time spent outdoors (on site)       ³ 1.140E-01 ³ 2.500E-01 ³
        ---                ³ FOTD
 R017 ³ Shape factor flag, external gamma               ³ 1.000E+00 ³ 1.000E+00 ³
 >0 shows circular AREA.   ³ FS
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                                                 Site-Specific Parameter Summary
(continued)
0     ³                                                 ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                   Parameter                     ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R017 ³ Radii of shape factor array (used if FS = -1):  ³           ³           ³
                           ³
 R017 ³   Outer annular radius (m), ring  1:            ³ not used  ³ 5.000E+01 ³
        ---                ³ RAD_SHAPE( 1)
 R017 ³   Outer annular radius (m), ring  2:            ³ not used  ³ 7.071E+01 ³
        ---                ³ RAD_SHAPE( 2)
 R017 ³   Outer annular radius (m), ring  3:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE( 3)
 R017 ³   Outer annular radius (m), ring  4:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE( 4)
 R017 ³   Outer annular radius (m), ring  5:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE( 5)
 R017 ³   Outer annular radius (m), ring  6:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE( 6)
 R017 ³   Outer annular radius (m), ring  7:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE( 7)
 R017 ³   Outer annular radius (m), ring  8:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE( 8)
 R017 ³   Outer annular radius (m), ring  9:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE( 9)
 R017 ³   Outer annular radius (m), ring 10:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE(10)
 R017 ³   Outer annular radius (m), ring 11:            ³ not used  ³ 0.000E+00 ³
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         ---                   ³ RAD_SHAPE(11)
R017 ³   Outer annular radius (m), ring 12:            ³ not used  ³ 0.000E+00 ³
         ---                   ³ RAD_SHAPE(12)
     ³                                                 ³           ³           ³
                               ³
R017 ³ Fractions of annular areas within AREA:         ³           ³           ³
                               ³
R017 ³   Ring  1                                       ³ not used  ³ 1.000E+00 ³
         ---                   ³ FRACA( 1)
R017 ³   Ring  2                                       ³ not used  ³ 2.732E-01 ³
         ---                   ³ FRACA( 2)
R017 ³   Ring  3                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA( 3)
R017 ³   Ring  4                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA( 4)
R017 ³   Ring  5                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA( 5)
R017 ³   Ring  6                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA( 6)
R017 ³   Ring  7                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA( 7)
R017 ³   Ring  8                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA( 8)
R017 ³   Ring  9                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA( 9)
R017 ³   Ring 10                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA(10)
R017 ³   Ring 11                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA(11)
R017 ³   Ring 12                                       ³ not used  ³ 0.000E+00 ³
         ---                   ³ FRACA(12)
     ³                                                 ³           ³           ³
                               ³
R018 ³ Fruits, vegetables and grain consumption (kg/yr) ³ not used  ³ 1.600E+02 ³
         ---                   ³ DIET(1)
R018 ³ Leafy vegetable consumption (kg/yr)             ³ not used  ³ 1.400E+01 ³
         ---                   ³ DIET(2)
R018 ³ Milk consumption (L/yr)                         ³ not used  ³ 9.200E+01 ³
         ---                   ³ DIET(3)
R018 ³ Meat and poultry consumption (kg/yr)            ³ not used  ³ 6.300E+01 ³
         ---                   ³ DIET(4)
R018 ³ Fish consumption (kg/yr)                        ³ not used  ³ 5.400E+00 ³
         ---                   ³ DIET(5)
R018 ³ Other seafood consumption (kg/yr)               ³ not used  ³ 9.000E-01 ³
         ---                   ³ DIET(6)
R018 ³ Soil ingestion rate (g/yr)                      ³ 1.095E+02 ³ 3.650E+01 ³
         ---                   ³ SOIL
R018 ³ Drinking water intake (L/yr)                    ³ not used  ³ 5.100E+02 ³
         ---                   ³ DWI
R018 ³ Contamination fraction of drinking water        ³ not used  ³ 1.000E+00 ³
         ---                   ³ FDW
R018 ³ Contamination fraction of household water       ³ not used  ³ 1.000E+00 ³
         ---                   ³ FHHW
R018 ³ Contamination fraction of livestock water       ³ not used  ³ 1.000E+00 ³
         ---                   ³ FLW
R018 ³ Contamination fraction of irrigation water      ³ not used  ³ 1.000E+00 ³
         ---                   ³ FIRW
R018 ³ Contamination fraction of aquatic food          ³ not used  ³ 5.000E-01 ³
         ---                   ³ FR9
R018 ³ Contamination fraction of plant food            ³ not used  ³-1         ³
         ---                   ³ FPLANT
R018 ³ Contamination fraction of meat                  ³ not used  ³-1         ³
         ---                   ³ FMEAT
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 R018 ³ Contamination fraction of milk                  ³ not used  ³-1          ³
          ---                 ³ FMILK
      ³                                                 ³           ³            ³
                              ³
 R019 ³ Livestock fodder intake for meat (kg/day)       ³ not used  ³ 6.800E+01 ³
          ---                 ³ LFI5
 R019 ³ Livestock fodder intake for milk (kg/day)       ³ not used  ³ 5.500E+01 ³
          ---                 ³ LFI6
 R019 ³ Livestock water intake for meat (L/day)         ³ not used  ³ 5.000E+01 ³
          ---                 ³ LWI5
 R019 ³ Livestock water intake for milk (L/day)         ³ not used  ³ 1.600E+02 ³
          ---                 ³ LWI6
 R019 ³ Livestock soil intake (kg/day)                  ³ not used  ³ 5.000E-01 ³
          ---                 ³ LSI
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(continued)
0     ³                                                 ³   User    ³            ³
      Used by RESRAD          ³  Parameter
 Menu ³                    Parameter                    ³   Input   ³  Default   ³
(If different from user input) ³    Name

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 R019 ³ Mass loading for foliar deposition (g/m**3)     ³ not used  ³ 1.000E-04 ³
          ---                 ³ MLFD
 R019 ³ Depth of soil mixing layer (m)                  ³ 1.500E-01 ³ 1.500E-01 ³
          ---                 ³ DM
 R019 ³ Depth of roots (m)                              ³ not used  ³ 9.000E-01 ³
          ---                 ³ DROOT
 R019 ³ Drinking water fraction from ground water       ³ not used  ³ 1.000E+00 ³
          ---                 ³ FGWDW
 R019 ³ Household water fraction from ground water      ³ not used  ³ 1.000E+00 ³
          ---                 ³ FGWHH
 R019 ³ Livestock water fraction from ground water      ³ not used  ³ 1.000E+00 ³
          ---                 ³ FGWLW
 R019 ³ Irrigation fraction from ground water           ³ not used  ³ 1.000E+00 ³
          ---                 ³ FGWIR
      ³                                                 ³           ³            ³
                              ³
 R19B ³ Wet weight crop yield for Non-Leafy (kg/m**2)   ³ not used  ³ 7.000E-01 ³
          ---                 ³ YV(1)
 R19B ³ Wet weight crop yield for Leafy     (kg/m**2)   ³ not used  ³ 1.500E+00 ³
          ---                 ³ YV(2)
 R19B ³ Wet weight crop yield for Fodder    (kg/m**2)   ³ not used  ³ 1.100E+00 ³
          ---                 ³ YV(3)
 R19B ³ Growing Season for  Non-Leafy (years)           ³ not used  ³ 1.700E-01 ³
          ---                 ³ TE(1)
 R19B ³ Growing Season for  Leafy     (years)           ³ not used  ³ 2.500E-01 ³
          ---                 ³ TE(2)
 R19B ³ Growing Season for  Fodder    (years)           ³ not used  ³ 8.000E-02 ³
          ---                 ³ TE(3)
 R19B ³ Translocation Factor for  Non-Leafy             ³ not used  ³ 1.000E-01 ³
          ---                 ³ TIV(1)
 R19B ³ Translocation Factor for  Leafy                 ³ not used  ³ 1.000E+00 ³
          ---                 ³ TIV(2)
 R19B ³ Translocation Factor for  Fodder                ³ not used  ³ 1.000E+00 ³
          ---                 ³ TIV(3)
 R19B ³ Dry Foliar Interception Fraction for  Non-Leafy ³ not used  ³ 2.500E-01 ³
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          ---               ³ RDRY(1)
R19B ³ Dry Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³
          ---               ³ RDRY(2)
R19B ³ Dry Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³
          ---               ³ RDRY(3)
R19B ³ Wet Foliar Interception Fraction for  Non-Leafy  ³ not used  ³ 2.500E-01 ³
          ---               ³ RWET(1)
R19B ³ Wet Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³
          ---               ³ RWET(2)
R19B ³ Wet Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³
          ---               ³ RWET(3)
R19B ³ Weathering Removal Constant for Vegetation       ³ not used  ³ 2.000E+01 ³
          ---               ³ WLAM
     ³                                                  ³           ³           ³
                            ³
C14  ³ C-12 concentration in water (g/cm**3)            ³ not used  ³ 2.000E-05 ³
          ---               ³ C12WTR
C14  ³ C-12 concentration in contaminated soil (g/g)    ³ not used  ³ 3.000E-02 ³
          ---               ³ C12CZ
C14  ³ Fraction of vegetation carbon from soil          ³ not used  ³ 2.000E-02 ³
          ---               ³ CSOIL
C14  ³ Fraction of vegetation carbon from air           ³ not used  ³ 9.800E-01 ³
          ---               ³ CAIR
C14  ³ C-14 evasion layer thickness in soil (m)         ³ not used  ³ 3.000E-01 ³
          ---               ³ DMC
C14  ³ C-14 evasion flux rate from soil (1/sec)         ³ not used  ³ 7.000E-07 ³
          ---               ³ EVSN
C14  ³ C-12 evasion flux rate from soil (1/sec)         ³ not used  ³ 1.000E-10 ³
          ---               ³ REVSN
C14  ³ Fraction of grain in beef cattle feed            ³ not used  ³ 8.000E-01 ³
          ---               ³ AVFG4
C14  ³ Fraction of grain in milk cow feed               ³ not used  ³ 2.000E-01 ³
          ---               ³ AVFG5
C14  ³ DCF correction factor for gaseous forms of C14   ³ not used  ³ 1.234E+02 ³
          ---               ³ CO2F
     ³                                                  ³           ³           ³
                            ³
STOR ³ Storage times of contaminated foodstuffs (days): ³           ³           ³
                            ³
STOR ³   Fruits, non-leafy vegetables, and grain        ³ 1.400E+01 ³ 1.400E+01 ³
          ---               ³ STOR_T(1)
STOR ³   Leafy vegetables                               ³ 1.000E+00 ³ 1.000E+00 ³
          ---               ³ STOR_T(2)
STOR ³   Milk                                           ³ 1.000E+00 ³ 1.000E+00 ³
          ---               ³ STOR_T(3)
STOR ³   Meat and poultry                               ³ 2.000E+01 ³ 2.000E+01 ³
          ---               ³ STOR_T(4)
STOR ³   Fish                                           ³ 7.000E+00 ³ 7.000E+00 ³
          ---               ³ STOR_T(5)
STOR ³   Crustacea and mollusks                         ³ 7.000E+00 ³ 7.000E+00 ³
          ---               ³ STOR_T(6)
STOR ³   Well water                                     ³ 1.000E+00 ³ 1.000E+00 ³
          ---               ³ STOR_T(7)
STOR ³   Surface water                                  ³ 1.000E+00 ³ 1.000E+00 ³
          ---               ³ STOR_T(8)
STOR ³   Livestock fodder                               ³ 4.500E+01 ³ 4.500E+01 ³
          ---               ³ STOR_T(9)
     ³                                                  ³           ³           ³
                            ³
R021 ³ Thickness of building foundation (m)             ³ not used  ³ 1.500E-01 ³
          ---               ³ FLOOR1
R021 ³ Bulk density of building foundation (g/cm**3)    ³ not used  ³ 2.400E+00 ³
          ---               ³ DENSFL
```

```
 R021 ³ Total porosity of the cover material           ³ not used  ³ 4.000E-01 ³
          ---                 ³ TPCV
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page   7
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                                           Site-Specific Parameter Summary
(continued)
0     ³                                                ³   User    ³           ³
      Used by RESRAD          ³  Parameter
 Menu ³                      Parameter                 ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R021 ³ Total porosity of the building foundation      ³ not used  ³ 1.000E-01 ³
          ---                 ³ TPFL
 R021 ³ Volumetric water content of the cover material ³ not used  ³ 5.000E-02 ³
          ---                 ³ PH2OCV
 R021 ³ Volumetric water content of the foundation     ³ not used  ³ 3.000E-02 ³
          ---                 ³ PH2OFL
 R021 ³ Diffusion coefficient for radon gas (m/sec):   ³           ³           ³
                              ³
 R021 ³   in cover material                            ³ not used  ³ 2.000E-06 ³
          ---                 ³ DIFCV
 R021 ³   in foundation material                       ³ not used  ³ 3.000E-07 ³
          ---                 ³ DIFFL
 R021 ³   in contaminated zone soil                    ³ not used  ³ 2.000E-06 ³
          ---                 ³ DIFCZ
 R021 ³ Radon vertical dimension of mixing (m)         ³ not used  ³ 2.000E+00 ³
          ---                 ³ HMIX
 R021 ³ Average building air exchange rate (1/hr)      ³ not used  ³ 5.000E-01 ³
          ---                 ³ REXG
 R021 ³ Height of the building (room) (m)              ³ not used  ³ 2.500E+00 ³
          ---                 ³ HRM
 R021 ³ Building interior area factor                  ³ not used  ³ 0.000E+00 ³
          ---                 ³ FAI
 R021 ³ Building depth below ground surface (m)        ³ not used  ³-1.000E+00 ³
          ---                 ³ DMFL
 R021 ³ Emanating power of Rn-222 gas                  ³ not used  ³ 2.500E-01 ³
          ---                 ³ EMANA(1)
 R021 ³ Emanating power of Rn-220 gas                  ³ not used  ³ 1.500E-01 ³
          ---                 ³ EMANA(2)
      ³                                                ³           ³           ³
                              ³
 TITL ³ Number of graphical time points                ³   32      ³    ---    ³
          ---                 ³ NPTS
 TITL ³ Maximum number of integration points for dose  ³  17       ³    ---    ³
          ---                 ³ LYMAX
 TITL ³ Maximum number of integration points for risk  ³ 257       ³    ---    ³
          ---                 ³ KYMAX

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                      Summary of Pathway Selections

                     Pathway             ³   User Selection
           ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
              1 -- external gamma        ³       active
```

```
              2 -- inhalation (w/o radon)³       active
              3 -- plant ingestion       ³     suppressed
              4 -- meat ingestion        ³     suppressed
              5 -- milk ingestion        ³     suppressed
              6 -- aquatic foods         ³     suppressed
              7 -- drinking water        ³     suppressed
              8 -- soil ingestion        ³       active
              9 -- radon                 ³     suppressed
              Find peak pathway doses    ³       active
           ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page   8
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

      Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:1400000.00 square meters                Pu-239     7.700E+00
   Thickness:      0.15 meters

 Cover Depth:      0.00 meters
0
                                     Total Dose TDOSE(t), mrem/yr

                               Basic Radiation Dose Limit =  25 mrem/yr

              Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time
(t)

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    t (years):  0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02
3.000E+02  1.000E+03
     TDOSE(t):  2.158E-01  2.156E-01  2.152E-01  2.136E-01  2.093E-01  1.948E-01
1.574E-01  6.481E-02
         M(t):  8.633E-03  8.624E-03  8.606E-03  8.546E-03  8.374E-03  7.793E-03
6.295E-03  2.592E-03
0Maximum TDOSE(t):  2.158E-01 mrem/yr   at t = 0.000E+00 years
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page   9
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
0.000E+00 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
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mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Total   3.532E-04 0.0016  3.677E-02 0.1704  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.787E-01 0.8280
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0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
0.000E+00 years
0                                                              Water Dependent Pathways
0             Water              Fish              Radon              Plant
  Meat              Milk         All Pathways*
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.158E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:18  Page  10
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+00 years
0                                               Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk             Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Total   3.530E-04 0.0016  3.673E-02 0.1704  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.785E-01 0.8280
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+00 years
0                                                              Water Dependent Pathways
0             Water              Fish              Radon              Plant
  Meat              Milk         All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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0.000E+00 0.0000  0.000E+00 0.0000  2.156E-01 1.0000
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0.000E+00 0.0000  0.000E+00 0.0000  2.156E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page  11
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+00 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
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0.000E+00 0.0000  0.000E+00 0.0000  1.781E-01 0.8280
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+00 years
0                                                      Water Dependent Pathways
0              Water             Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.152E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page  12
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+01 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
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 Total   3.512E-04 0.0016  3.640E-02 0.1704  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.769E-01 0.8280
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+01 years
0                                                      Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.136E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.136E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:18  Page  13
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+01 years
0                                  Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  3.473E-04 0.0017  3.567E-02 0.1704  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.733E-01 0.8280
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 Total   3.473E-04 0.0017  3.567E-02 0.1704  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.733E-01 0.8280
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+01 years

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0                                                          Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.093E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.093E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page  14
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+02 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation            Radon              Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  3.339E-04 0.0017  3.319E-02 0.1704  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.613E-01 0.8279
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 Total   3.339E-04 0.0017  3.319E-02 0.1704  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.613E-01 0.8279
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+02 years
0                                                          Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.948E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.948E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page  15
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 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+02 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon             Plant
  Meat             Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  2.975E-04 0.0019  2.681E-02 0.1703  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.303E-01 0.8278
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 Total   2.975E-04 0.0019  2.681E-02 0.1703  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.303E-01 0.8278
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+02 years
0                                                      Water Dependent Pathways
0              Water             Fish              Radon             Plant
  Meat             Milk         All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.574E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.574E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page  16
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+03 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon             Plant
  Meat             Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  1.862E-04 0.0029  1.103E-02 0.1702  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  5.360E-02 0.8270
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 Total   1.862E-04 0.0029  1.103E-02 0.1702  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  5.360E-02 0.8270
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+03 years
0                                                           Water Dependent Pathways
0              Water               Fish                Radon               Plant
  Meat               Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  6.481E-02 1.0000
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ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  6.481E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:18  Page  17
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                                 Dose/Source Ratios Summed Over All Pathways

                      Parent and Progeny Principal Radionuclide Contributions
Indicated
0Parent  Product  Branch                             DSR(j,t)  (mrem/yr)/(pCi/g)

  (i)      (j)   Fraction* t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
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 Pu-239  Pu-239  1.000E+00    2.803E-02 2.800E-02 2.794E-02 2.775E-02 2.719E-02
2.530E-02 2.044E-02 8.417E-03
 Pu-239  U-235   1.000E+00    5.413E-11 1.350E-10 2.186E-10 2.716E-10 2.707E-10
2.595E-10 2.294E-10 1.381E-10
 Pu-239  Pa-231  1.000E+00    1.008E-15 6.220E-15 2.535E-14 1.119E-13 3.062E-13
5.499E-13 5.077E-13 2.186E-13
 Pu-239  Ac-227  1.000E+00    2.088E-17 2.797E-16 2.566E-15 3.287E-14 1.959E-13
5.068E-13 5.027E-13 2.441E-13
 Pu-239  äDSR(j)              2.803E-02 2.800E-02 2.794E-02 2.775E-02 2.719E-02
2.530E-02 2.044E-02 8.417E-03
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 *Branch Fraction is the cumulative factor for the j't principal radionuclide
daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
 The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

0
                            Single Radionuclide Soil Guidelines G(i,t) in pCi/g

                                 Basic Radiation Dose Limit =  25 mrem/yr
```

```
0Nuclide
   (i)    t= 0.000E+00   1.000E+00   3.000E+00   1.000E+01   3.000E+01   1.000E+02
3.000E+02   1.000E+03
 ÄÄÄÄÄÄÄ     ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
 Pu-239      8.920E+02   8.929E+02   8.947E+02   9.010E+02   9.195E+02   9.881E+02
1.223E+03   2.970E+03
 ÍÍÍÍÍÍÍ     ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ
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0
             Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
             and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
          at tmin = time of minimum single radionuclide soil guideline
      and at tmax = time of maximum total dose = 0.000E+00 years
0Nuclide  Initial        tmin       DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
   (i)     pCi/g        (years)                  (pCi/g)                (pCi/g)
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ
 Pu-239  7.700E+00     0.000E+00      2.803E-02  8.920E+02  2.803E-02  8.920E+02
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ

1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:18  Page  18
 Summary : Wildlife Refuge Worker Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRW.RAD

                              Individual Nuclide Dose Summed Over All Pathways
                                Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   BRF(i)                                   DOSE(j,t), mrem/yr
   (j)     (i)           t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
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 Pu-239  Pu-239  1.000E+00    2.158E-01 2.156E-01 2.152E-01 2.136E-01 2.093E-01
1.948E-01 1.574E-01 6.481E-02
0U-235   Pu-239  1.000E+00    4.168E-10 1.039E-09 1.683E-09 2.092E-09 2.085E-09
1.998E-09 1.766E-09 1.063E-09
0Pa-231  Pu-239  1.000E+00    7.759E-15 4.789E-14 1.952E-13 8.618E-13 2.358E-12
4.234E-12 3.909E-12 1.683E-12
0Ac-227  Pu-239  1.000E+00    1.608E-16 2.154E-15 1.976E-14 2.531E-13 1.509E-12
3.902E-12 3.871E-12 1.880E-12
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 BRF(i) is the branch fraction of the parent nuclide.



                                   Individual Nuclide Soil Concentration
                                Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   BRF(i)                                     S(j,t), pCi/g
   (j)     (i)           t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
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 Pu-239  Pu-239  1.000E+00    7.700E+00 7.696E+00 7.688E+00 7.661E+00 7.583E+00
7.316E+00 6.603E+00 4.614E+00
0U-235   Pu-239  1.000E+00    0.000E+00 6.091E-09 1.240E-08 1.642E-08 1.643E-08
1.585E-08 1.431E-08 9.997E-09
0Pa-231  Pu-239  1.000E+00    0.000E+00 6.878E-14 4.690E-13 2.513E-12 7.247E-12
1.361E-11 1.394E-11 9.757E-12
0Ac-227  Pu-239  1.000E+00    0.000E+00 7.417E-16 1.548E-14 2.720E-13 1.768E-12
4.780E-12 5.128E-12 3.590E-12
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 BRF(i) is the branch fraction of the parent nuclide.
0RESMAIN5.EXE execution time =    1.11 seconds

# RESRAD OUTPUT

# WILDLIFE REFUGE VISITOR – ADULT – TIER 2

 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown EU - 2
 File    : WBWRVA.RAD

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Part I: Mixture Sums and Single Radionuclide Guidelines
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 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown EU - 2
 File    : WBWRVA.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: 77001589.LIB

| Menu | Parameter | Current Value | Default | Parameter Name |
|---|---|---|---|---|
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Ac-227+D | 6.720E+00 | 6.720E+00 | DCF2( 1) |
| B-1 | Pa-231 | 1.280E+00 | 1.280E+00 | DCF2( 2) |
| B-1 | Pu-239 | 1.900E-01 | 4.290E-01 | DCF2( 3) |
| B-1 | U-235+D | 1.230E-01 | 1.230E-01 | DCF2( 4) |
| | | | | |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Ac-227+D | 1.480E-02 | 1.480E-02 | DCF3( 1) |
| D-1 | Pa-231 | 1.060E-02 | 1.060E-02 | DCF3( 2) |
| D-1 | Pu-239 | 9.300E-04 | 3.540E-03 | DCF3( 3) |
| D-1 | U-235+D | 2.670E-04 | 2.670E-04 | DCF3( 4) |

```
     ³                                                           ³           ³
      ³
 D-34 ³ Food transfer factors:                                   ³           ³
      ³
 D-34 ³ Ac-227+D , plant/soil concentration ratio, dimensionless ³ 2.500E-03 ³
2.500E-03 ³ RTF( 1,1)
 D-34 ³ Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) ³ 2.000E-05 ³
2.000E-05 ³ RTF( 1,2)
 D-34 ³ Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  ³ 2.000E-05 ³
2.000E-05 ³ RTF( 1,3)
 D-34 ³                                                          ³           ³
      ³
 D-34 ³ Pa-231   , plant/soil concentration ratio, dimensionless ³ 1.000E-02 ³
1.000E-02 ³ RTF( 2,1)
 D-34 ³ Pa-231   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) ³ 5.000E-03 ³
5.000E-03 ³ RTF( 2,2)
 D-34 ³ Pa-231   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  ³ 5.000E-06 ³
5.000E-06 ³ RTF( 2,3)
 D-34 ³                                                          ³           ³
      ³
 D-34 ³ Pu-239   , plant/soil concentration ratio, dimensionless ³ 5.800E-05 ³
1.000E-03 ³ RTF( 3,1)
 D-34 ³ Pu-239   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) ³ 1.000E-04 ³
1.000E-04 ³ RTF( 3,2)
 D-34 ³ Pu-239   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  ³ 1.000E-06 ³
1.000E-06 ³ RTF( 3,3)
 D-34 ³                                                          ³           ³
      ³
 D-34 ³ U-235+D  , plant/soil concentration ratio, dimensionless ³ 2.500E-03 ³
2.500E-03 ³ RTF( 4,1)
 D-34 ³ U-235+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) ³ 3.400E-04 ³
3.400E-04 ³ RTF( 4,2)
 D-34 ³ U-235+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)  ³ 6.000E-04 ³
6.000E-04 ³ RTF( 4,3)
     ³                                                           ³           ³
      ³
 D-5  ³ Bioaccumulation factors, fresh water, L/kg:              ³           ³
      ³
 D-5  ³ Ac-227+D , fish                                          ³ 1.500E+01 ³
1.500E+01 ³ BIOFAC( 1,1)
 D-5  ³ Ac-227+D , crustacea and mollusks                        ³ 1.000E+03 ³
1.000E+03 ³ BIOFAC( 1,2)
 D-5  ³                                                          ³           ³
      ³
 D-5  ³ Pa-231   , fish                                          ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC( 2,1)
 D-5  ³ Pa-231   , crustacea and mollusks                        ³ 1.100E+02 ³
1.100E+02 ³ BIOFAC( 2,2)
 D-5  ³                                                          ³           ³
      ³
 D-5  ³ Pu-239   , fish                                          ³ 3.000E+01 ³
3.000E+01 ³ BIOFAC( 3,1)
 D-5  ³ Pu-239   , crustacea and mollusks                        ³ 1.000E+02 ³
1.000E+02 ³ BIOFAC( 3,2)
 D-5  ³                                                          ³           ³
      ³
 D-5  ³ U-235+D  , fish                                          ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC( 4,1)
 D-5  ³ U-235+D  , crustacea and mollusks                        ³ 6.000E+01 ³
6.000E+01 ³ BIOFAC( 4,2)

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1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:20  Page   3
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                                                          Site-Specific Parameter Summary
0     ³                                                                  ³   User    ³            ³
      Used by RESRAD          ³  Parameter
 Menu ³                      Parameter                                   ³   Input   ³  Default   ³
(If different from user input) ³    Name

ÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄ
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 R011 ³ Area of contaminated zone (m**2)                                 ³ 1.400E+06 ³ 1.000E+04 ³
          ---                 ³ AREA
 R011 ³ Thickness of contaminated zone (m)                               ³ 1.500E-01 ³ 2.000E+00 ³
          ---                 ³ THICK0
 R011 ³ Length parallel to aquifer flow (m)                              ³ not used  ³ 1.000E+02 ³
          ---                 ³ LCZPAQ
 R011 ³ Basic radiation dose limit (mrem/yr)                             ³ 2.500E+01 ³ 2.500E+01 ³
          ---                 ³ BRDL
 R011 ³ Time since placement of material (yr)                            ³ 0.000E+00 ³ 0.000E+00 ³
          ---                 ³ TI
 R011 ³ Times for calculations (yr)                                      ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ T( 2)
 R011 ³ Times for calculations (yr)                                      ³ 3.000E+00 ³ 3.000E+00 ³
          ---                 ³ T( 3)
 R011 ³ Times for calculations (yr)                                      ³ 1.000E+01 ³ 1.000E+01 ³
          ---                 ³ T( 4)
 R011 ³ Times for calculations (yr)                                      ³ 3.000E+01 ³ 3.000E+01 ³
          ---                 ³ T( 5)
 R011 ³ Times for calculations (yr)                                      ³ 1.000E+02 ³ 1.000E+02 ³
          ---                 ³ T( 6)
 R011 ³ Times for calculations (yr)                                      ³ 3.000E+02 ³ 3.000E+02 ³
          ---                 ³ T( 7)
 R011 ³ Times for calculations (yr)                                      ³ 1.000E+03 ³ 1.000E+03 ³
          ---                 ³ T( 8)
 R011 ³ Times for calculations (yr)                                      ³ not used  ³ 0.000E+00 ³
          ---                 ³ T( 9)
 R011 ³ Times for calculations (yr)                                      ³ not used  ³ 0.000E+00 ³
          ---                 ³ T(10)
      ³                                                                  ³           ³            ³
                              ³
 R012 ³ Initial principal radionuclide (pCi/g):  Pu-239                  ³ 7.700E+00 ³ 0.000E+00 ³
          ---                 ³ S1( 3)
 R012 ³ Concentration in groundwater   (pCi/L):  Pu-239                  ³ not used  ³ 0.000E+00 ³
          ---                 ³ W1( 3)
      ³                                                                  ³           ³            ³
                              ³
 R013 ³ Cover depth (m)                                                  ³ 0.000E+00 ³ 0.000E+00 ³
          ---                 ³ COVER0
 R013 ³ Density of cover material (g/cm**3)                              ³ not used  ³ 1.500E+00 ³
          ---                 ³ DENSCV
 R013 ³ Cover depth erosion rate (m/yr)                                  ³ not used  ³ 1.000E-03 ³
          ---                 ³ VCV
 R013 ³ Density of contaminated zone (g/cm**3)                           ³ 1.700E+00 ³ 1.500E+00 ³
          ---                 ³ DENSCZ
 R013 ³ Contaminated zone erosion rate (m/yr)                            ³ 7.490E-05 ³ 1.000E-03 ³
          ---                 ³ VCZ
 R013 ³ Contaminated zone total porosity                                 ³ 3.000E-01 ³ 4.000E-01 ³
          ---                 ³ TPCZ
 R013 ³ Contaminated zone field capacity                                 ³ 1.000E-01 ³ 2.000E-01 ³
          ---                 ³ FCCZ
```

```
 R013 ³ Contaminated zone hydraulic conductivity (m/yr)  ³ 4.450E+01 ³ 1.000E+01 ³
          ---                ³ HCCZ
 R013 ³ Contaminated zone b parameter                    ³ 1.040E+01 ³ 5.300E+00 ³
          ---                ³ BCZ
 R013 ³ Average annual wind speed (m/sec)                ³ 4.200E+00 ³ 2.000E+00 ³
          ---                ³ WIND
 R013 ³ Humidity in air (g/m**3)                         ³ not used  ³ 8.000E+00 ³
          ---                ³ HUMID
 R013 ³ Evapotranspiration coefficient                   ³ 2.530E-01 ³ 5.000E-01 ³
          ---                ³ EVAPTR
 R013 ³ Precipitation (m/yr)                             ³ 3.810E-01 ³ 1.000E+00 ³
          ---                ³ PRECIP
 R013 ³ Irrigation (m/yr)                                ³ 0.000E+00 ³ 2.000E-01 ³
          ---                ³ RI
 R013 ³ Irrigation mode                                  ³ overhead  ³ overhead  ³
          ---                ³ IDITCH
 R013 ³ Runoff coefficient                               ³ 4.000E-03 ³ 2.000E-01 ³
          ---                ³ RUNOFF
 R013 ³ Watershed area for nearby stream or pond (m**2)  ³ not used  ³ 1.000E+06 ³
          ---                ³ WAREA
 R013 ³ Accuracy for water/soil computations             ³ not used  ³ 1.000E-03 ³
          ---                ³ EPS
      ³                                                  ³           ³           ³
                             ³
 R014 ³ Density of saturated zone (g/cm**3)              ³ not used  ³ 1.500E+00 ³
          ---                ³ DENSAQ
 R014 ³ Saturated zone total porosity                    ³ not used  ³ 4.000E-01 ³
          ---                ³ TPSZ
 R014 ³ Saturated zone effective porosity                ³ not used  ³ 2.000E-01 ³
          ---                ³ EPSZ
 R014 ³ Saturated zone field capacity                    ³ not used  ³ 2.000E-01 ³
          ---                ³ FCSZ
 R014 ³ Saturated zone hydraulic conductivity (m/yr)     ³ not used  ³ 1.000E+02 ³
          ---                ³ HCSZ
 R014 ³ Saturated zone hydraulic gradient                ³ not used  ³ 2.000E-02 ³
          ---                ³ HGWT
 R014 ³ Saturated zone b parameter                       ³ not used  ³ 5.300E+00 ³
          ---                ³ BSZ
 R014 ³ Water table drop rate (m/yr)                     ³ not used  ³ 1.000E-03 ³
          ---                ³ VWT
 R014 ³ Well pump intake depth (m below water table)     ³ not used  ³ 1.000E+01 ³
          ---                ³ DWIBWT
 R014 ³ Model: Nondispersion (ND) or Mass-Balance (MB)   ³ not used  ³ ND        ³
          ---                ³ MODEL
 R014 ³ Well pumping rate (m**3/yr)                      ³ not used  ³ 2.500E+02 ³
          ---                ³ UW
      ³                                                  ³           ³           ³
                             ³
 R015 ³ Number of unsaturated zone strata                ³ not used  ³ 1         ³
          ---                ³ NS
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:20  Page   4
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                                           Site-Specific Parameter Summary
(continued)
0     ³                                                  ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                    Parameter                     ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R015 ³ Unsat. zone 1, thickness (m)                ³ not used  ³ 4.000E+00 ³
     ---              ³ H(1)
 R015 ³ Unsat. zone 1, soil density (g/cm**3)       ³ not used  ³ 1.500E+00 ³
     ---              ³ DENSUZ(1)
 R015 ³ Unsat. zone 1, total porosity               ³ not used  ³ 4.000E-01 ³
     ---              ³ TPUZ(1)
 R015 ³ Unsat. zone 1, effective porosity           ³ not used  ³ 2.000E-01 ³
     ---              ³ EPUZ(1)
 R015 ³ Unsat. zone 1, field capacity               ³ not used  ³ 2.000E-01 ³
     ---              ³ FCUZ(1)
 R015 ³ Unsat. zone 1, soil-specific b parameter    ³ not used  ³ 5.300E+00 ³
     ---              ³ BUZ(1)
 R015 ³ Unsat. zone 1, hydraulic conductivity (m/yr)  ³ not used  ³ 1.000E+01 ³
     ---              ³ HCUZ(1)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for Pu-239        ³           ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 2.300E+03 ³ 2.000E+03 ³
     ---              ³ DCNUCC( 3)
 R016 ³   Unsaturated zone 1 (cm**3/g)              ³ not used  ³ 2.000E+03 ³
     ---              ³ DCNUCU( 3,1)
 R016 ³   Saturated zone (cm**3/g)                  ³ not used  ³ 2.000E+03 ³
     ---              ³ DCNUCS( 3)
 R016 ³   Leach rate (/yr)                          ³ 0.000E+00 ³ 0.000E+00 ³
   4.833E-04          ³ ALEACH( 3)
 R016 ³   Solubility constant                       ³ 0.000E+00 ³ 0.000E+00 ³
   not used           ³ SOLUBK( 3)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for daughter Ac-227  ³           ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 2.000E+01 ³ 2.000E+01 ³
     ---              ³ DCNUCC( 1)
 R016 ³   Unsaturated zone 1 (cm**3/g)              ³ not used  ³ 2.000E+01 ³
     ---              ³ DCNUCU( 1,1)
 R016 ³   Saturated zone (cm**3/g)                  ³ not used  ³ 2.000E+01 ³
     ---              ³ DCNUCS( 1)
 R016 ³   Leach rate (/yr)                          ³ 0.000E+00 ³ 0.000E+00 ³
   5.519E-02          ³ ALEACH( 1)
 R016 ³   Solubility constant                       ³ 0.000E+00 ³ 0.000E+00 ³
   not used           ³ SOLUBK( 1)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for daughter Pa-231  ³           ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 5.000E+01 ³ 5.000E+01 ³
     ---              ³ DCNUCC( 2)
 R016 ³   Unsaturated zone 1 (cm**3/g)              ³ not used  ³ 5.000E+01 ³
     ---              ³ DCNUCU( 2,1)
 R016 ³   Saturated zone (cm**3/g)                  ³ not used  ³ 5.000E+01 ³
     ---              ³ DCNUCS( 2)
 R016 ³   Leach rate (/yr)                          ³ 0.000E+00 ³ 0.000E+00 ³
   2.217E-02          ³ ALEACH( 2)
 R016 ³   Solubility constant                       ³ 0.000E+00 ³ 0.000E+00 ³
   not used           ³ SOLUBK( 2)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for daughter U-235  ³           ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 2.300E+00 ³ 5.000E+01 ³
     ---              ³ DCNUCC( 4)
```

```
 R016 ³   Unsaturated zone 1 (cm**3/g)                   ³ not used  ³ 5.000E+01 ³
        ---                 ³ DCNUCU( 4,1)
 R016 ³   Saturated zone (cm**3/g)                       ³ not used  ³ 5.000E+01 ³
        ---                 ³ DCNUCS( 4)
 R016 ³   Leach rate (/yr)                               ³ 0.000E+00 ³ 0.000E+00 ³
      4.551E-01             ³ ALEACH( 4)
 R016 ³   Solubility constant                            ³ 0.000E+00 ³ 0.000E+00 ³
      not used              ³ SOLUBK( 4)
      ³                                                  ³           ³           ³
                            ³
 R017 ³ Inhalation rate (m**3/yr)                        ³ 2.000E+04 ³ 8.400E+03 ³
        ---                 ³ INHALR
 R017 ³ Mass loading for inhalation (g/m**3)             ³ 6.700E-05 ³ 1.000E-04 ³
        ---                 ³ MLINH
 R017 ³ Exposure duration                                ³ 3.000E+01 ³ 3.000E+01 ³
        ---                 ³ ED
 R017 ³ Shielding factor, inhalation                     ³ 7.000E-01 ³ 4.000E-01 ³
        ---                 ³ SHF3
 R017 ³ Shielding factor, external gamma                 ³ 4.000E-01 ³ 7.000E-01 ³
        ---                 ³ SHF1
 R017 ³ Fraction of time spent indoors                   ³ 0.000E+00 ³ 5.000E-01 ³
        ---                 ³ FIND
 R017 ³ Fraction of time spent outdoors (on site)        ³ 3.000E-02 ³ 2.500E-01 ³
        ---                 ³ FOTD
 R017 ³ Shape factor flag, external gamma                ³ 1.000E+00 ³ 1.000E+00 ³
 >0 shows circular AREA.    ³ FS
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                                             Site-Specific Parameter Summary
(continued)
0     ³                                                  ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                    Parameter                     ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R017 ³ Radii of shape factor array (used if FS = -1):   ³           ³           ³
                            ³
 R017 ³   Outer annular radius (m), ring  1:             ³ not used  ³ 5.000E+01 ³
        ---                 ³ RAD_SHAPE( 1)
 R017 ³   Outer annular radius (m), ring  2:             ³ not used  ³ 7.071E+01 ³
        ---                 ³ RAD_SHAPE( 2)
 R017 ³   Outer annular radius (m), ring  3:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE( 3)
 R017 ³   Outer annular radius (m), ring  4:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE( 4)
 R017 ³   Outer annular radius (m), ring  5:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE( 5)
 R017 ³   Outer annular radius (m), ring  6:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE( 6)
 R017 ³   Outer annular radius (m), ring  7:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE( 7)
 R017 ³   Outer annular radius (m), ring  8:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE( 8)
 R017 ³   Outer annular radius (m), ring  9:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE( 9)
 R017 ³   Outer annular radius (m), ring 10:             ³ not used  ³ 0.000E+00 ³
        ---                 ³ RAD_SHAPE(10)
 R017 ³   Outer annular radius (m), ring 11:             ³ not used  ³ 0.000E+00 ³
```

```
          ---                  ³ RAD_SHAPE(11)
R017 ³   Outer annular radius (m), ring 12:           ³ not used  ³ 0.000E+00 ³
          ---                  ³ RAD_SHAPE(12)
     ³                                                ³           ³           ³
                               ³
R017 ³ Fractions of annular areas within AREA:        ³           ³           ³
                               ³
R017 ³   Ring  1                                      ³ not used  ³ 1.000E+00 ³
          ---                  ³ FRACA( 1)
R017 ³   Ring  2                                      ³ not used  ³ 2.732E-01 ³
          ---                  ³ FRACA( 2)
R017 ³   Ring  3                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA( 3)
R017 ³   Ring  4                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA( 4)
R017 ³   Ring  5                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA( 5)
R017 ³   Ring  6                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA( 6)
R017 ³   Ring  7                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA( 7)
R017 ³   Ring  8                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA( 8)
R017 ³   Ring  9                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA( 9)
R017 ³   Ring 10                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA(10)
R017 ³   Ring 11                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA(11)
R017 ³   Ring 12                                      ³ not used  ³ 0.000E+00 ³
          ---                  ³ FRACA(12)
     ³                                                ³           ³           ³
                               ³
R018 ³ Fruits, vegetables and grain consumption (kg/yr) ³ not used  ³ 1.600E+02 ³
          ---                  ³ DIET(1)
R018 ³ Leafy vegetable consumption (kg/yr)            ³ not used  ³ 1.400E+01 ³
          ---                  ³ DIET(2)
R018 ³ Milk consumption (L/yr)                        ³ not used  ³ 9.200E+01 ³
          ---                  ³ DIET(3)
R018 ³ Meat and poultry consumption (kg/yr)           ³ not used  ³ 6.300E+01 ³
          ---                  ³ DIET(4)
R018 ³ Fish consumption (kg/yr)                       ³ not used  ³ 5.400E+00 ³
          ---                  ³ DIET(5)
R018 ³ Other seafood consumption (kg/yr)              ³ not used  ³ 9.000E-01 ³
          ---                  ³ DIET(6)
R018 ³ Soil ingestion rate (g/yr)                     ³ 1.752E+02 ³ 3.650E+01 ³
          ---                  ³ SOIL
R018 ³ Drinking water intake (L/yr)                   ³ not used  ³ 5.100E+02 ³
          ---                  ³ DWI
R018 ³ Contamination fraction of drinking water       ³ not used  ³ 1.000E+00 ³
          ---                  ³ FDW
R018 ³ Contamination fraction of household water      ³ not used  ³ 1.000E+00 ³
          ---                  ³ FHHW
R018 ³ Contamination fraction of livestock water      ³ not used  ³ 1.000E+00 ³
          ---                  ³ FLW
R018 ³ Contamination fraction of irrigation water     ³ not used  ³ 1.000E+00 ³
          ---                  ³ FIRW
R018 ³ Contamination fraction of aquatic food         ³ not used  ³ 5.000E-01 ³
          ---                  ³ FR9
R018 ³ Contamination fraction of plant food           ³ not used  ³-1         ³
          ---                  ³ FPLANT
R018 ³ Contamination fraction of meat                 ³ not used  ³-1         ³
          ---                  ³ FMEAT
```

```
 R018 ³ Contamination fraction of milk                   ³ not used  ³-1          ³
          ---              ³ FMILK
      ³                                                  ³           ³            ³
                           ³
 R019 ³ Livestock fodder intake for meat (kg/day)        ³ not used  ³ 6.800E+01 ³
          ---              ³ LFI5
 R019 ³ Livestock fodder intake for milk (kg/day)        ³ not used  ³ 5.500E+01 ³
          ---              ³ LFI6
 R019 ³ Livestock water intake for meat (L/day)          ³ not used  ³ 5.000E+01 ³
          ---              ³ LWI5
 R019 ³ Livestock water intake for milk (L/day)          ³ not used  ³ 1.600E+02 ³
          ---              ³ LWI6
 R019 ³ Livestock soil intake (kg/day)                   ³ not used  ³ 5.000E-01 ³
          ---              ³ LSI
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                                          Site-Specific Parameter Summary
(continued)
0     ³                                                  ³   User    ³            ³
      Used by RESRAD          ³  Parameter
 Menu ³                    Parameter                     ³   Input   ³  Default   ³
(If different from user input) ³    Name

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 R019 ³ Mass loading for foliar deposition (g/m**3)      ³ not used  ³ 1.000E-04 ³
          ---              ³ MLFD
 R019 ³ Depth of soil mixing layer (m)                   ³ 1.500E-01 ³ 1.500E-01 ³
          ---              ³ DM
 R019 ³ Depth of roots (m)                               ³ not used  ³ 9.000E-01 ³
          ---              ³ DROOT
 R019 ³ Drinking water fraction from ground water        ³ not used  ³ 1.000E+00 ³
          ---              ³ FGWDW
 R019 ³ Household water fraction from ground water       ³ not used  ³ 1.000E+00 ³
          ---              ³ FGWHH
 R019 ³ Livestock water fraction from ground water       ³ not used  ³ 1.000E+00 ³
          ---              ³ FGWLW
 R019 ³ Irrigation fraction from ground water            ³ not used  ³ 1.000E+00 ³
          ---              ³ FGWIR
      ³                                                  ³           ³            ³
                           ³
 R19B ³ Wet weight crop yield for Non-Leafy (kg/m**2)    ³ not used  ³ 7.000E-01 ³
          ---              ³ YV(1)
 R19B ³ Wet weight crop yield for Leafy     (kg/m**2)    ³ not used  ³ 1.500E+00 ³
          ---              ³ YV(2)
 R19B ³ Wet weight crop yield for Fodder    (kg/m**2)    ³ not used  ³ 1.100E+00 ³
          ---              ³ YV(3)
 R19B ³ Growing Season for  Non-Leafy (years)            ³ not used  ³ 1.700E-01 ³
          ---              ³ TE(1)
 R19B ³ Growing Season for  Leafy     (years)            ³ not used  ³ 2.500E-01 ³
          ---              ³ TE(2)
 R19B ³ Growing Season for  Fodder    (years)            ³ not used  ³ 8.000E-02 ³
          ---              ³ TE(3)
 R19B ³ Translocation Factor for  Non-Leafy              ³ not used  ³ 1.000E-01 ³
          ---              ³ TIV(1)
 R19B ³ Translocation Factor for  Leafy                  ³ not used  ³ 1.000E+00 ³
          ---              ³ TIV(2)
 R19B ³ Translocation Factor for  Fodder                 ³ not used  ³ 1.000E+00 ³
          ---              ³ TIV(3)
 R19B ³ Dry Foliar Interception Fraction for  Non-Leafy  ³ not used  ³ 2.500E-01 ³
```

```
          ---                ³ RDRY(1)
R19B ³ Dry Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³
          ---                ³ RDRY(2)
R19B ³ Dry Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³
          ---                ³ RDRY(3)
R19B ³ Wet Foliar Interception Fraction for  Non-Leafy  ³ not used  ³ 2.500E-01 ³
          ---                ³ RWET(1)
R19B ³ Wet Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³
          ---                ³ RWET(2)
R19B ³ Wet Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³
          ---                ³ RWET(3)
R19B ³ Weathering Removal Constant for Vegetation       ³ not used  ³ 2.000E+01 ³
          ---                ³ WLAM
     ³                                                  ³           ³           ³
                             ³
C14  ³ C-12 concentration in water (g/cm**3)            ³ not used  ³ 2.000E-05 ³
          ---                ³ C12WTR
C14  ³ C-12 concentration in contaminated soil (g/g)    ³ not used  ³ 3.000E-02 ³
          ---                ³ C12CZ
C14  ³ Fraction of vegetation carbon from soil          ³ not used  ³ 2.000E-02 ³
          ---                ³ CSOIL
C14  ³ Fraction of vegetation carbon from air           ³ not used  ³ 9.800E-01 ³
          ---                ³ CAIR
C14  ³ C-14 evasion layer thickness in soil (m)         ³ not used  ³ 3.000E-01 ³
          ---                ³ DMC
C14  ³ C-14 evasion flux rate from soil (1/sec)         ³ not used  ³ 7.000E-07 ³
          ---                ³ EVSN
C14  ³ C-12 evasion flux rate from soil (1/sec)         ³ not used  ³ 1.000E-10 ³
          ---                ³ REVSN
C14  ³ Fraction of grain in beef cattle feed            ³ not used  ³ 8.000E-01 ³
          ---                ³ AVFG4
C14  ³ Fraction of grain in milk cow feed               ³ not used  ³ 2.000E-01 ³
          ---                ³ AVFG5
C14  ³ DCF correction factor for gaseous forms of C14   ³ not used  ³ 1.234E+02 ³
          ---                ³ CO2F
     ³                                                  ³           ³           ³
                             ³
STOR ³ Storage times of contaminated foodstuffs (days): ³           ³           ³
                             ³
STOR ³   Fruits, non-leafy vegetables, and grain        ³ 1.400E+01 ³ 1.400E+01 ³
          ---                ³ STOR_T(1)
STOR ³   Leafy vegetables                               ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(2)
STOR ³   Milk                                           ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(3)
STOR ³   Meat and poultry                               ³ 2.000E+01 ³ 2.000E+01 ³
          ---                ³ STOR_T(4)
STOR ³   Fish                                           ³ 7.000E+00 ³ 7.000E+00 ³
          ---                ³ STOR_T(5)
STOR ³   Crustacea and mollusks                         ³ 7.000E+00 ³ 7.000E+00 ³
          ---                ³ STOR_T(6)
STOR ³   Well water                                     ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(7)
STOR ³   Surface water                                  ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(8)
STOR ³   Livestock fodder                               ³ 4.500E+01 ³ 4.500E+01 ³
          ---                ³ STOR_T(9)
     ³                                                  ³           ³           ³
                             ³
R021 ³ Thickness of building foundation (m)             ³ not used  ³ 1.500E-01 ³
          ---                ³ FLOOR1
R021 ³ Bulk density of building foundation (g/cm**3)    ³ not used  ³ 2.400E+00 ³
          ---                ³ DENSFL
```

```
 R021 ³ Total porosity of the cover material          ³ not used  ³ 4.000E-01 ³
          ---                ³ TPCV
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(continued)
0     ³                                               ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                      Parameter                ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R021 ³ Total porosity of the building foundation     ³ not used  ³ 1.000E-01 ³
          ---                ³ TPFL
 R021 ³ Volumetric water content of the cover material ³ not used  ³ 5.000E-02 ³
          ---                ³ PH2OCV
 R021 ³ Volumetric water content of the foundation    ³ not used  ³ 3.000E-02 ³
          ---                ³ PH2OFL
 R021 ³ Diffusion coefficient for radon gas (m/sec):  ³           ³           ³
                             ³
 R021 ³   in cover material                           ³ not used  ³ 2.000E-06 ³
          ---                ³ DIFCV
 R021 ³   in foundation material                      ³ not used  ³ 3.000E-07 ³
          ---                ³ DIFFL
 R021 ³   in contaminated zone soil                   ³ not used  ³ 2.000E-06 ³
          ---                ³ DIFCZ
 R021 ³ Radon vertical dimension of mixing (m)        ³ not used  ³ 2.000E+00 ³
          ---                ³ HMIX
 R021 ³ Average building air exchange rate (1/hr)     ³ not used  ³ 5.000E-01 ³
          ---                ³ REXG
 R021 ³ Height of the building (room) (m)             ³ not used  ³ 2.500E+00 ³
          ---                ³ HRM
 R021 ³ Building interior area factor                 ³ not used  ³ 0.000E+00 ³
          ---                ³ FAI
 R021 ³ Building depth below ground surface (m)       ³ not used  ³-1.000E+00 ³
          ---                ³ DMFL
 R021 ³ Emanating power of Rn-222 gas                 ³ not used  ³ 2.500E-01 ³
          ---                ³ EMANA(1)
 R021 ³ Emanating power of Rn-220 gas                 ³ not used  ³ 1.500E-01 ³
          ---                ³ EMANA(2)
      ³                                               ³           ³           ³
                             ³
 TITL ³ Number of graphical time points               ³   32      ³    ---    ³
          ---                ³ NPTS
 TITL ³ Maximum number of integration points for dose ³  17       ³    ---    ³
          ---                ³ LYMAX
 TITL ³ Maximum number of integration points for risk ³ 257       ³    ---    ³
          ---                ³ KYMAX

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                      Summary of Pathway Selections

                     Pathway              ³   User Selection
           ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
              1 -- external gamma         ³       active
```

```
              2 -- inhalation (w/o radon)³      active
              3 -- plant ingestion       ³    suppressed
              4 -- meat ingestion        ³    suppressed
              5 -- milk ingestion        ³    suppressed
              6 -- aquatic foods         ³    suppressed
              7 -- drinking water        ³    suppressed
              8 -- soil ingestion        ³      active
              9 -- radon                 ³    suppressed
              Find peak pathway doses    ³      active
           ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
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      Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:1400000.00 square meters                Pu-239     7.700E+00
   Thickness:      0.15 meters

 Cover Depth:      0.00 meters
0
                                     Total Dose TDOSE(t), mrem/yr

                               Basic Radiation Dose Limit =  25 mrem/yr

              Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time
(t)

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    t (years):  0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02
3.000E+02  1.000E+03
     TDOSE(t):  4.582E-02  4.577E-02  4.568E-02  4.536E-02  4.444E-02  4.136E-02
3.341E-02  1.376E-02
         M(t):  1.833E-03  1.831E-03  1.827E-03  1.814E-03  1.778E-03  1.654E-03
1.336E-03  5.503E-04
0Maximum TDOSE(t):  4.582E-02 mrem/yr   at t = 0.000E+00 years
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                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
0.000E+00 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon             Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.638E-05 0.0014  8.131E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.762E-02 0.8211
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 Total   6.638E-05 0.0014  8.131E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.762E-02 0.8211
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0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
0.000E+00 years
0                                                          Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.582E-02 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.582E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:20  Page  10
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+00 years
0                                   Water Independent Pathways (Inhalation
excludes radon)
0             Ground           Inhalation           Radon              Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.
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 Pu-239  6.635E-05 0.0014  8.123E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.758E-02 0.8211
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 Total   6.635E-05 0.0014  8.123E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.758E-02 0.8211
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+00 years
0                                                          Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.  mrem/yr  fract.  mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.577E-02 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.577E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:20  Page  11
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+00 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation          Radon             Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.627E-05 0.0015  8.106E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.751E-02 0.8211
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 Total   6.627E-05 0.0015  8.106E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.751E-02 0.8211
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+00 years
0                                                     Water Dependent Pathways
0              Water            Fish             Radon             Plant
  Meat              Milk         All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.568E-02 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.568E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:20  Page  12
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+01 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation          Radon             Plant
  Meat              Milk              Soil
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 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.601E-05 0.0015  8.049E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.724E-02 0.8211
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 Total   6.601E-05 0.0015  8.049E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.724E-02 0.8211
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+01 years
0                                                       Water Dependent Pathways
0              Water             Fish              Radon              Plant
  Meat             Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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0.000E+00 0.0000  0.000E+00 0.0000  4.536E-02 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.536E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:20  Page  13
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+01 years
0                                   Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat             Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.528E-05 0.0015  7.887E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.649E-02 0.8211
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 Total   6.528E-05 0.0015  7.887E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.649E-02 0.8211
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+01 years
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0                                                         Water Dependent Pathways
0             Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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0.000E+00 0.0000  0.000E+00 0.0000  4.444E-02 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.444E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:20  Page  14
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+02 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0            Ground          Inhalation           Radon              Plant
  Meat              Milk             Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.276E-05 0.0015  7.339E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.396E-02 0.8210
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 Total   6.276E-05 0.0015  7.339E-03 0.1775  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.396E-02 0.8210
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+02 years
0                                                         Water Dependent Pathways
0             Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.136E-02 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.136E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:20  Page  15
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 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+02 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation          Radon            Plant
  Meat             Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  5.592E-05 0.0017  5.928E-03 0.1774  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.743E-02 0.8209
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 Total   5.592E-05 0.0017  5.928E-03 0.1774  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  2.743E-02 0.8209
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+02 years
0                                                           Water Dependent Pathways
0              Water             Fish              Radon            Plant
  Meat             Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.341E-02 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.341E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:20  Page  16
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+03 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation          Radon            Plant
  Meat             Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  3.499E-05 0.0025  2.439E-03 0.1773  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.128E-02 0.8202
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
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 Total   3.499E-05 0.0025  2.439E-03 0.1773  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.128E-02 0.8202
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+03 years
0                                                          Water Dependent Pathways
0              Water            Fish              Radon             Plant
  Meat              Milk           All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.376E-02 1.0000
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.376E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:20  Page  17
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                                         Dose/Source Ratios Summed Over All Pathways

                              Parent and Progeny Principal Radionuclide Contributions
Indicated
0Parent  Product  Branch                              DSR(j,t)  (mrem/yr)/(pCi/g)

  (i)      (j)   Fraction* t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
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 Pu-239  Pu-239  1.000E+00    5.950E-03 5.944E-03 5.932E-03 5.890E-03 5.772E-03
5.371E-03 4.339E-03 1.787E-03
 Pu-239  U-235   1.000E+00    1.028E-11 2.564E-11 4.152E-11 5.160E-11 5.142E-11
4.928E-11 4.351E-11 2.613E-11
 Pu-239  Pa-231  1.000E+00    2.112E-16 1.303E-15 5.313E-15 2.345E-14 6.417E-14
1.152E-13 1.063E-13 4.555E-14
 Pu-239  Ac-227  1.000E+00    4.270E-18 5.719E-17 5.247E-16 6.720E-15 4.005E-14
1.035E-13 1.024E-13 4.914E-14
 Pu-239  äDSR(j)              5.950E-03 5.944E-03 5.932E-03 5.890E-03 5.772E-03
5.371E-03 4.339E-03 1.787E-03
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 *Branch Fraction is the cumulative factor for the j't principal radionuclide
daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
 The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

0
                            Single Radionuclide Soil Guidelines G(i,t) in pCi/g

                                 Basic Radiation Dose Limit =  25 mrem/yr
```

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0Nuclide
   (i)    t= 0.000E+00   1.000E+00   3.000E+00   1.000E+01   3.000E+01   1.000E+02
3.000E+02   1.000E+03
 ÄÄÄÄÄÄÄ     ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
 Pu-239      4.202E+03   4.206E+03   4.214E+03   4.244E+03   4.331E+03   4.654E+03
5.761E+03   1.399E+04
 ÍÍÍÍÍÍÍ     ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ
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0
             Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
             and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
          at tmin = time of minimum single radionuclide soil guideline
      and at tmax = time of maximum total dose = 0.000E+00 years
0Nuclide  Initial         tmin       DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
   (i)     pCi/g        (years)                    (pCi/g)                (pCi/g)
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 Pu-239  7.700E+00     0.000E+00      5.950E-03  4.202E+03  5.950E-03  4.202E+03
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1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:20  Page  18
 Summary : Wildlife Refuge Visitor Adult Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVA.RAD

                               Individual Nuclide Dose Summed Over All Pathways
                                 Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   BRF(i)                                   DOSE(j,t), mrem/yr
   (j)     (i)           t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
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 Pu-239  Pu-239  1.000E+00    4.582E-02 4.577E-02 4.568E-02 4.536E-02 4.444E-02
4.136E-02 3.341E-02 1.376E-02
0U-235   Pu-239  1.000E+00    7.918E-11 1.974E-10 3.197E-10 3.973E-10 3.959E-10
3.795E-10 3.350E-10 2.012E-10
0Pa-231  Pu-239  1.000E+00    1.626E-15 1.004E-14 4.091E-14 1.806E-13 4.941E-13
8.870E-13 8.182E-13 3.508E-13
0Ac-227  Pu-239  1.000E+00    3.288E-17 4.404E-16 4.040E-15 5.174E-14 3.084E-13
7.969E-13 7.883E-13 3.784E-13
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 BRF(i) is the branch fraction of the parent nuclide.



                                    Individual Nuclide Soil Concentration
                                 Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   BRF(i)                                     S(j,t), pCi/g
   (j)     (i)           t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
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 Pu-239  Pu-239  1.000E+00    7.700E+00 7.696E+00 7.688E+00 7.661E+00 7.583E+00
7.316E+00 6.603E+00 4.614E+00
0U-235   Pu-239  1.000E+00    0.000E+00 6.091E-09 1.240E-08 1.642E-08 1.643E-08
1.585E-08 1.431E-08 9.997E-09
0Pa-231  Pu-239  1.000E+00    0.000E+00 6.878E-14 4.690E-13 2.513E-12 7.247E-12
1.361E-11 1.394E-11 9.757E-12
0Ac-227  Pu-239  1.000E+00    0.000E+00 7.417E-16 1.548E-14 2.720E-13 1.768E-12
4.780E-12 5.128E-12 3.590E-12
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 BRF(i) is the branch fraction of the parent nuclide.
0RESMAIN5.EXE execution time =    0.82 seconds
```

# RESRAD OUTPUT

# WILDLIFE REFUGE VISITOR – CHILD – TIER 2

```
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:21  Page   1
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

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      Time = 0.000E+00 ....................................    9
      Time = 1.000E+00 ....................................   10
      Time = 3.000E+00 ....................................   11
      Time = 1.000E+01 ....................................   12
      Time = 3.000E+01 ....................................   13
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                           Dose Conversion Factor (and Related) Parameter Summary
                                                  File: 11954897.LIB
0     ³                                                            ³  Current  ³
       ³  Parameter
 Menu ³                         Parameter                          ³   Value   ³
Default  ³    Name

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 B-1  ³ Dose conversion factors for inhalation, mrem/pCi:          ³           ³
       ³
 B-1  ³ Ac-227+D                                                   ³ 6.720E+00 ³
6.720E+00 ³ DCF2( 1)
 B-1  ³ Pa-231                                                     ³ 1.280E+00 ³
1.280E+00 ³ DCF2( 2)
 B-1  ³ Pu-239                                                     ³ 2.900E-01 ³
4.290E-01 ³ DCF2( 3)
 B-1  ³ U-235+D                                                    ³ 1.230E-01 ³
1.230E-01 ³ DCF2( 4)
      ³                                                            ³           ³
       ³
 D-1  ³ Dose conversion factors for ingestion, mrem/pCi:           ³           ³
       ³
 D-1  ³ Ac-227+D                                                   ³ 1.480E-02 ³
1.480E-02 ³ DCF3( 1)
 D-1  ³ Pa-231                                                     ³ 1.060E-02 ³
1.060E-02 ³ DCF3( 2)
 D-1  ³ Pu-239                                                     ³ 1.600E-03 ³
3.540E-03 ³ DCF3( 3)
 D-1  ³ U-235+D                                                    ³ 2.670E-04 ³
2.670E-04 ³ DCF3( 4)
```

```
      ³                                                             ³           ³
        ³
 D-34 ³ Food transfer factors:                                      ³           ³
        ³
 D-34 ³ Ac-227+D , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³
2.500E-03 ³ RTF( 1,1)
 D-34 ³ Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 2.000E-05 ³
2.000E-05 ³ RTF( 1,2)
 D-34 ³ Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 2.000E-05 ³
2.000E-05 ³ RTF( 1,3)
 D-34 ³                                                             ³           ³
        ³
 D-34 ³ Pa-231   , plant/soil concentration ratio, dimensionless    ³ 1.000E-02 ³
1.000E-02 ³ RTF( 2,1)
 D-34 ³ Pa-231   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 5.000E-03 ³
5.000E-03 ³ RTF( 2,2)
 D-34 ³ Pa-231   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 5.000E-06 ³
5.000E-06 ³ RTF( 2,3)
 D-34 ³                                                             ³           ³
        ³
 D-34 ³ Pu-239   , plant/soil concentration ratio, dimensionless    ³ 5.800E-05 ³
1.000E-03 ³ RTF( 3,1)
 D-34 ³ Pu-239   , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 1.000E-04 ³
1.000E-04 ³ RTF( 3,2)
 D-34 ³ Pu-239   , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 1.000E-06 ³
1.000E-06 ³ RTF( 3,3)
 D-34 ³                                                             ³           ³
        ³
 D-34 ³ U-235+D  , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³
2.500E-03 ³ RTF( 4,1)
 D-34 ³ U-235+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 3.400E-04 ³
3.400E-04 ³ RTF( 4,2)
 D-34 ³ U-235+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 6.000E-04 ³
6.000E-04 ³ RTF( 4,3)
      ³                                                             ³           ³
        ³
 D-5  ³ Bioaccumulation factors, fresh water, L/kg:                 ³           ³
        ³
 D-5  ³ Ac-227+D , fish                                             ³ 1.500E+01 ³
1.500E+01 ³ BIOFAC( 1,1)
 D-5  ³ Ac-227+D , crustacea and mollusks                           ³ 1.000E+03 ³
1.000E+03 ³ BIOFAC( 1,2)
 D-5  ³                                                             ³           ³
        ³
 D-5  ³ Pa-231   , fish                                             ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC( 2,1)
 D-5  ³ Pa-231   , crustacea and mollusks                           ³ 1.100E+02 ³
1.100E+02 ³ BIOFAC( 2,2)
 D-5  ³                                                             ³           ³
        ³
 D-5  ³ Pu-239   , fish                                             ³ 3.000E+01 ³
3.000E+01 ³ BIOFAC( 3,1)
 D-5  ³ Pu-239   , crustacea and mollusks                           ³ 1.000E+02 ³
1.000E+02 ³ BIOFAC( 3,2)
 D-5  ³                                                             ³           ³
        ³
 D-5  ³ U-235+D  , fish                                             ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC( 4,1)
 D-5  ³ U-235+D  , crustacea and mollusks                           ³ 6.000E+01 ³
6.000E+01 ³ BIOFAC( 4,2)

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                                                          Site-Specific Parameter Summary
0     ³                                                          ³   User    ³           ³
      Used by RESRAD          ³  Parameter
 Menu ³                     Parameter                            ³   Input   ³  Default  ³
(If different from user input) ³    Name

ÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 R011 ³ Area of contaminated zone (m**2)                         ³ 1.400E+06 ³ 1.000E+04 ³
          ---                 ³ AREA
 R011 ³ Thickness of contaminated zone (m)                       ³ 1.500E-01 ³ 2.000E+00 ³
          ---                 ³ THICK0
 R011 ³ Length parallel to aquifer flow (m)                      ³ not used  ³ 1.000E+02 ³
          ---                 ³ LCZPAQ
 R011 ³ Basic radiation dose limit (mrem/yr)                     ³ 2.500E+01 ³ 2.500E+01 ³
          ---                 ³ BRDL
 R011 ³ Time since placement of material (yr)                    ³ 0.000E+00 ³ 0.000E+00 ³
          ---                 ³ TI
 R011 ³ Times for calculations (yr)                              ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ T( 2)
 R011 ³ Times for calculations (yr)                              ³ 3.000E+00 ³ 3.000E+00 ³
          ---                 ³ T( 3)
 R011 ³ Times for calculations (yr)                              ³ 1.000E+01 ³ 1.000E+01 ³
          ---                 ³ T( 4)
 R011 ³ Times for calculations (yr)                              ³ 3.000E+01 ³ 3.000E+01 ³
          ---                 ³ T( 5)
 R011 ³ Times for calculations (yr)                              ³ 1.000E+02 ³ 1.000E+02 ³
          ---                 ³ T( 6)
 R011 ³ Times for calculations (yr)                              ³ 3.000E+02 ³ 3.000E+02 ³
          ---                 ³ T( 7)
 R011 ³ Times for calculations (yr)                              ³ 1.000E+03 ³ 1.000E+03 ³
          ---                 ³ T( 8)
 R011 ³ Times for calculations (yr)                              ³ not used  ³ 0.000E+00 ³
          ---                 ³ T( 9)
 R011 ³ Times for calculations (yr)                              ³ not used  ³ 0.000E+00 ³
          ---                 ³ T(10)
      ³                                                          ³           ³           ³
                              ³
 R012 ³ Initial principal radionuclide (pCi/g):  Pu-239          ³ 7.700E+00 ³ 0.000E+00 ³
          ---                 ³ S1( 3)
 R012 ³ Concentration in groundwater   (pCi/L):  Pu-239          ³ not used  ³ 0.000E+00 ³
          ---                 ³ W1( 3)
      ³                                                          ³           ³           ³
                              ³
 R013 ³ Cover depth (m)                                          ³ 0.000E+00 ³ 0.000E+00 ³
          ---                 ³ COVER0
 R013 ³ Density of cover material (g/cm**3)                      ³ not used  ³ 1.500E+00 ³
          ---                 ³ DENSCV
 R013 ³ Cover depth erosion rate (m/yr)                          ³ not used  ³ 1.000E-03 ³
          ---                 ³ VCV
 R013 ³ Density of contaminated zone (g/cm**3)                   ³ 1.700E+00 ³ 1.500E+00 ³
          ---                 ³ DENSCZ
 R013 ³ Contaminated zone erosion rate (m/yr)                    ³ 7.490E-05 ³ 1.000E-03 ³
          ---                 ³ VCZ
 R013 ³ Contaminated zone total porosity                         ³ 3.000E-01 ³ 4.000E-01 ³
          ---                 ³ TPCZ
 R013 ³ Contaminated zone field capacity                         ³ 1.000E-01 ³ 2.000E-01 ³
          ---                 ³ FCCZ
```

```
 R013 ³ Contaminated zone hydraulic conductivity (m/yr)  ³ 4.450E+01 ³ 1.000E+01 ³
        ---              ³ HCCZ
 R013 ³ Contaminated zone b parameter                    ³ 1.040E+01 ³ 5.300E+00 ³
        ---              ³ BCZ
 R013 ³ Average annual wind speed (m/sec)                ³ 4.200E+00 ³ 2.000E+00 ³
        ---              ³ WIND
 R013 ³ Humidity in air (g/m**3)                         ³ not used  ³ 8.000E+00 ³
        ---              ³ HUMID
 R013 ³ Evapotranspiration coefficient                   ³ 2.530E-01 ³ 5.000E-01 ³
        ---              ³ EVAPTR
 R013 ³ Precipitation (m/yr)                             ³ 3.810E-01 ³ 1.000E+00 ³
        ---              ³ PRECIP
 R013 ³ Irrigation (m/yr)                                ³ 0.000E+00 ³ 2.000E-01 ³
        ---              ³ RI
 R013 ³ Irrigation mode                                  ³ overhead  ³ overhead  ³
        ---              ³ IDITCH
 R013 ³ Runoff coefficient                               ³ 4.000E-03 ³ 2.000E-01 ³
        ---              ³ RUNOFF
 R013 ³ Watershed area for nearby stream or pond (m**2)  ³ not used  ³ 1.000E+06 ³
        ---              ³ WAREA
 R013 ³ Accuracy for water/soil computations             ³ not used  ³ 1.000E-03 ³
        ---              ³ EPS
      ³                                                  ³           ³           ³
                         ³
 R014 ³ Density of saturated zone (g/cm**3)              ³ not used  ³ 1.500E+00 ³
        ---              ³ DENSAQ
 R014 ³ Saturated zone total porosity                    ³ not used  ³ 4.000E-01 ³
        ---              ³ TPSZ
 R014 ³ Saturated zone effective porosity                ³ not used  ³ 2.000E-01 ³
        ---              ³ EPSZ
 R014 ³ Saturated zone field capacity                    ³ not used  ³ 2.000E-01 ³
        ---              ³ FCSZ
 R014 ³ Saturated zone hydraulic conductivity (m/yr)     ³ not used  ³ 1.000E+02 ³
        ---              ³ HCSZ
 R014 ³ Saturated zone hydraulic gradient                ³ not used  ³ 2.000E-02 ³
        ---              ³ HGWT
 R014 ³ Saturated zone b parameter                       ³ not used  ³ 5.300E+00 ³
        ---              ³ BSZ
 R014 ³ Water table drop rate (m/yr)                     ³ not used  ³ 1.000E-03 ³
        ---              ³ VWT
 R014 ³ Well pump intake depth (m below water table)     ³ not used  ³ 1.000E+01 ³
        ---              ³ DWIBWT
 R014 ³ Model: Nondispersion (ND) or Mass-Balance (MB)   ³ not used  ³ ND        ³
        ---              ³ MODEL
 R014 ³ Well pumping rate (m**3/yr)                      ³ not used  ³ 2.500E+02 ³
        ---              ³ UW
      ³                                                  ³           ³           ³
                         ³
 R015 ³ Number of unsaturated zone strata                ³ not used  ³ 1         ³
        ---              ³ NS
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                                           Site-Specific Parameter Summary
(continued)
0     ³                                                  ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                    Parameter                     ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R015 ³ Unsat. zone 1, thickness (m)                ³ not used  ³ 4.000E+00 ³
     ---              ³ H(1)
 R015 ³ Unsat. zone 1, soil density (g/cm**3)       ³ not used  ³ 1.500E+00 ³
     ---              ³ DENSUZ(1)
 R015 ³ Unsat. zone 1, total porosity               ³ not used  ³ 4.000E-01 ³
     ---              ³ TPUZ(1)
 R015 ³ Unsat. zone 1, effective porosity           ³ not used  ³ 2.000E-01 ³
     ---              ³ EPUZ(1)
 R015 ³ Unsat. zone 1, field capacity               ³ not used  ³ 2.000E-01 ³
     ---              ³ FCUZ(1)
 R015 ³ Unsat. zone 1, soil-specific b parameter    ³ not used  ³ 5.300E+00 ³
     ---              ³ BUZ(1)
 R015 ³ Unsat. zone 1, hydraulic conductivity (m/yr)  ³ not used  ³ 1.000E+01 ³
     ---              ³ HCUZ(1)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for Pu-239        ³           ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 2.300E+03 ³ 2.000E+03 ³
     ---              ³ DCNUCC( 3)
 R016 ³   Unsaturated zone 1 (cm**3/g)              ³ not used  ³ 2.000E+03 ³
     ---              ³ DCNUCU( 3,1)
 R016 ³   Saturated zone (cm**3/g)                  ³ not used  ³ 2.000E+03 ³
     ---              ³ DCNUCS( 3)
 R016 ³   Leach rate (/yr)                          ³ 0.000E+00 ³ 0.000E+00 ³
   4.833E-04          ³ ALEACH( 3)
 R016 ³   Solubility constant                       ³ 0.000E+00 ³ 0.000E+00 ³
   not used           ³ SOLUBK( 3)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for daughter Ac-227  ³        ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 2.000E+01 ³ 2.000E+01 ³
     ---              ³ DCNUCC( 1)
 R016 ³   Unsaturated zone 1 (cm**3/g)              ³ not used  ³ 2.000E+01 ³
     ---              ³ DCNUCU( 1,1)
 R016 ³   Saturated zone (cm**3/g)                  ³ not used  ³ 2.000E+01 ³
     ---              ³ DCNUCS( 1)
 R016 ³   Leach rate (/yr)                          ³ 0.000E+00 ³ 0.000E+00 ³
   5.519E-02          ³ ALEACH( 1)
 R016 ³   Solubility constant                       ³ 0.000E+00 ³ 0.000E+00 ³
   not used           ³ SOLUBK( 1)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for daughter Pa-231  ³        ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 5.000E+01 ³ 5.000E+01 ³
     ---              ³ DCNUCC( 2)
 R016 ³   Unsaturated zone 1 (cm**3/g)              ³ not used  ³ 5.000E+01 ³
     ---              ³ DCNUCU( 2,1)
 R016 ³   Saturated zone (cm**3/g)                  ³ not used  ³ 5.000E+01 ³
     ---              ³ DCNUCS( 2)
 R016 ³   Leach rate (/yr)                          ³ 0.000E+00 ³ 0.000E+00 ³
   2.217E-02          ³ ALEACH( 2)
 R016 ³   Solubility constant                       ³ 0.000E+00 ³ 0.000E+00 ³
   not used           ³ SOLUBK( 2)
      ³                                             ³           ³           ³
                      ³
 R016 ³ Distribution coefficients for daughter U-235   ³        ³           ³
                      ³
 R016 ³   Contaminated zone (cm**3/g)               ³ 2.300E+00 ³ 5.000E+01 ³
     ---              ³ DCNUCC( 4)
```

```
 R016 ³   Unsaturated zone 1 (cm**3/g)                  ³ not used  ³ 5.000E+01 ³
        ---              ³ DCNUCU( 4,1)
 R016 ³   Saturated zone (cm**3/g)                      ³ not used  ³ 5.000E+01 ³
        ---              ³ DCNUCS( 4)
 R016 ³   Leach rate (/yr)                              ³ 0.000E+00 ³ 0.000E+00 ³
       4.551E-01         ³ ALEACH( 4)
 R016 ³   Solubility constant                           ³ 0.000E+00 ³ 0.000E+00 ³
       not used          ³ SOLUBK( 4)
      ³                                                 ³           ³           ³
                         ³
 R017 ³ Inhalation rate (m**3/yr)                       ³ 1.400E+04 ³ 8.400E+03 ³
        ---              ³ INHALR
 R017 ³ Mass loading for inhalation (g/m**3)            ³ 6.700E-05 ³ 1.000E-04 ³
        ---              ³ MLINH
 R017 ³ Exposure duration                               ³ 3.000E+01 ³ 3.000E+01 ³
        ---              ³ ED
 R017 ³ Shielding factor, inhalation                    ³ 7.000E-01 ³ 4.000E-01 ³
        ---              ³ SHF3
 R017 ³ Shielding factor, external gamma                ³ 4.000E-01 ³ 7.000E-01 ³
        ---              ³ SHF1
 R017 ³ Fraction of time spent indoors                  ³ 0.000E+00 ³ 5.000E-01 ³
        ---              ³ FIND
 R017 ³ Fraction of time spent outdoors (on site)       ³ 3.000E-02 ³ 2.500E-01 ³
        ---              ³ FOTD
 R017 ³ Shape factor flag, external gamma               ³ 1.000E+00 ³ 1.000E+00 ³
 >0 shows circular AREA.     ³ FS
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                                                Site-Specific Parameter Summary
(continued)
0     ³                                                 ³   User    ³           ³
      Used by RESRAD         ³  Parameter
 Menu ³                   Parameter                     ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R017 ³ Radii of shape factor array (used if FS = -1):   ³           ³           ³
                         ³
 R017 ³   Outer annular radius (m), ring  1:            ³ not used  ³ 5.000E+01 ³
        ---              ³ RAD_SHAPE( 1)
 R017 ³   Outer annular radius (m), ring  2:            ³ not used  ³ 7.071E+01 ³
        ---              ³ RAD_SHAPE( 2)
 R017 ³   Outer annular radius (m), ring  3:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE( 3)
 R017 ³   Outer annular radius (m), ring  4:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE( 4)
 R017 ³   Outer annular radius (m), ring  5:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE( 5)
 R017 ³   Outer annular radius (m), ring  6:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE( 6)
 R017 ³   Outer annular radius (m), ring  7:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE( 7)
 R017 ³   Outer annular radius (m), ring  8:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE( 8)
 R017 ³   Outer annular radius (m), ring  9:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE( 9)
 R017 ³   Outer annular radius (m), ring 10:            ³ not used  ³ 0.000E+00 ³
        ---              ³ RAD_SHAPE(10)
 R017 ³   Outer annular radius (m), ring 11:            ³ not used  ³ 0.000E+00 ³
```

```
        ---                ³ RAD_SHAPE(11)
R017 ³   Outer annular radius (m), ring 12:            ³ not used  ³ 0.000E+00 ³
        ---                ³ RAD_SHAPE(12)
     ³                                                 ³           ³           ³
                           ³
R017 ³ Fractions of annular areas within AREA:         ³           ³           ³
                           ³
R017 ³   Ring  1                                       ³ not used  ³ 1.000E+00 ³
        ---                ³ FRACA( 1)
R017 ³   Ring  2                                       ³ not used  ³ 2.732E-01 ³
        ---                ³ FRACA( 2)
R017 ³   Ring  3                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA( 3)
R017 ³   Ring  4                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA( 4)
R017 ³   Ring  5                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA( 5)
R017 ³   Ring  6                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA( 6)
R017 ³   Ring  7                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA( 7)
R017 ³   Ring  8                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA( 8)
R017 ³   Ring  9                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA( 9)
R017 ³   Ring 10                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA(10)
R017 ³   Ring 11                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA(11)
R017 ³   Ring 12                                       ³ not used  ³ 0.000E+00 ³
        ---                ³ FRACA(12)
     ³                                                 ³           ³           ³
                           ³
R018 ³ Fruits, vegetables and grain consumption (kg/yr) ³ not used  ³ 1.600E+02 ³
        ---                ³ DIET(1)
R018 ³ Leafy vegetable consumption (kg/yr)             ³ not used  ³ 1.400E+01 ³
        ---                ³ DIET(2)
R018 ³ Milk consumption (L/yr)                         ³ not used  ³ 9.200E+01 ³
        ---                ³ DIET(3)
R018 ³ Meat and poultry consumption (kg/yr)            ³ not used  ³ 6.300E+01 ³
        ---                ³ DIET(4)
R018 ³ Fish consumption (kg/yr)                        ³ not used  ³ 5.400E+00 ³
        ---                ³ DIET(5)
R018 ³ Other seafood consumption (kg/yr)               ³ not used  ³ 9.000E-01 ³
        ---                ³ DIET(6)
R018 ³ Soil ingestion rate (g/yr)                      ³ 3.504E+02 ³ 3.650E+01 ³
        ---                ³ SOIL
R018 ³ Drinking water intake (L/yr)                    ³ not used  ³ 5.100E+02 ³
        ---                ³ DWI
R018 ³ Contamination fraction of drinking water        ³ not used  ³ 1.000E+00 ³
        ---                ³ FDW
R018 ³ Contamination fraction of household water       ³ not used  ³ 1.000E+00 ³
        ---                ³ FHHW
R018 ³ Contamination fraction of livestock water       ³ not used  ³ 1.000E+00 ³
        ---                ³ FLW
R018 ³ Contamination fraction of irrigation water      ³ not used  ³ 1.000E+00 ³
        ---                ³ FIRW
R018 ³ Contamination fraction of aquatic food          ³ not used  ³ 5.000E-01 ³
        ---                ³ FR9
R018 ³ Contamination fraction of plant food            ³ not used  ³-1         ³
        ---                ³ FPLANT
R018 ³ Contamination fraction of meat                  ³ not used  ³-1         ³
        ---                ³ FMEAT
```

```
 R018 ³ Contamination fraction of milk                    ³ not used  ³-1          ³
          ---                ³ FMILK
      ³                                                   ³           ³            ³
                             ³
 R019 ³ Livestock fodder intake for meat (kg/day)         ³ not used  ³ 6.800E+01 ³
          ---                ³ LFI5
 R019 ³ Livestock fodder intake for milk (kg/day)         ³ not used  ³ 5.500E+01 ³
          ---                ³ LFI6
 R019 ³ Livestock water intake for meat (L/day)           ³ not used  ³ 5.000E+01 ³
          ---                ³ LWI5
 R019 ³ Livestock water intake for milk (L/day)           ³ not used  ³ 1.600E+02 ³
          ---                ³ LWI6
 R019 ³ Livestock soil intake (kg/day)                    ³ not used  ³ 5.000E-01 ³
          ---                ³ LSI
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page   6
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
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                                          Site-Specific Parameter Summary
(continued)
0     ³                                                   ³   User    ³            ³
      Used by RESRAD          ³  Parameter
 Menu ³                    Parameter                      ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R019 ³ Mass loading for foliar deposition (g/m**3)       ³ not used  ³ 1.000E-04 ³
          ---                ³ MLFD
 R019 ³ Depth of soil mixing layer (m)                    ³ 1.500E-01 ³ 1.500E-01 ³
          ---                ³ DM
 R019 ³ Depth of roots (m)                                ³ not used  ³ 9.000E-01 ³
          ---                ³ DROOT
 R019 ³ Drinking water fraction from ground water         ³ not used  ³ 1.000E+00 ³
          ---                ³ FGWDW
 R019 ³ Household water fraction from ground water        ³ not used  ³ 1.000E+00 ³
          ---                ³ FGWHH
 R019 ³ Livestock water fraction from ground water        ³ not used  ³ 1.000E+00 ³
          ---                ³ FGWLW
 R019 ³ Irrigation fraction from ground water             ³ not used  ³ 1.000E+00 ³
          ---                ³ FGWIR
      ³                                                   ³           ³            ³
                             ³
 R19B ³ Wet weight crop yield for Non-Leafy (kg/m**2)     ³ not used  ³ 7.000E-01 ³
          ---                ³ YV(1)
 R19B ³ Wet weight crop yield for Leafy     (kg/m**2)     ³ not used  ³ 1.500E+00 ³
          ---                ³ YV(2)
 R19B ³ Wet weight crop yield for Fodder    (kg/m**2)     ³ not used  ³ 1.100E+00 ³
          ---                ³ YV(3)
 R19B ³ Growing Season for  Non-Leafy (years)             ³ not used  ³ 1.700E-01 ³
          ---                ³ TE(1)
 R19B ³ Growing Season for  Leafy     (years)             ³ not used  ³ 2.500E-01 ³
          ---                ³ TE(2)
 R19B ³ Growing Season for  Fodder    (years)             ³ not used  ³ 8.000E-02 ³
          ---                ³ TE(3)
 R19B ³ Translocation Factor for  Non-Leafy               ³ not used  ³ 1.000E-01 ³
          ---                ³ TIV(1)
 R19B ³ Translocation Factor for  Leafy                   ³ not used  ³ 1.000E+00 ³
          ---                ³ TIV(2)
 R19B ³ Translocation Factor for  Fodder                  ³ not used  ³ 1.000E+00 ³
          ---                ³ TIV(3)
 R19B ³ Dry Foliar Interception Fraction for  Non-Leafy  ³ not used  ³ 2.500E-01 ³
```

```
     ---                 ³ RDRY(1)
R19B ³ Dry Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³
     ---                 ³ RDRY(2)
R19B ³ Dry Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³
     ---                 ³ RDRY(3)
R19B ³ Wet Foliar Interception Fraction for  Non-Leafy  ³ not used  ³ 2.500E-01 ³
     ---                 ³ RWET(1)
R19B ³ Wet Foliar Interception Fraction for  Leafy      ³ not used  ³ 2.500E-01 ³
     ---                 ³ RWET(2)
R19B ³ Wet Foliar Interception Fraction for  Fodder     ³ not used  ³ 2.500E-01 ³
     ---                 ³ RWET(3)
R19B ³ Weathering Removal Constant for Vegetation       ³ not used  ³ 2.000E+01 ³
     ---                 ³ WLAM
     ³                                                  ³           ³           ³
                         ³
C14  ³ C-12 concentration in water (g/cm**3)            ³ not used  ³ 2.000E-05 ³
     ---                 ³ C12WTR
C14  ³ C-12 concentration in contaminated soil (g/g)    ³ not used  ³ 3.000E-02 ³
     ---                 ³ C12CZ
C14  ³ Fraction of vegetation carbon from soil          ³ not used  ³ 2.000E-02 ³
     ---                 ³ CSOIL
C14  ³ Fraction of vegetation carbon from air           ³ not used  ³ 9.800E-01 ³
     ---                 ³ CAIR
C14  ³ C-14 evasion layer thickness in soil (m)         ³ not used  ³ 3.000E-01 ³
     ---                 ³ DMC
C14  ³ C-14 evasion flux rate from soil (1/sec)         ³ not used  ³ 7.000E-07 ³
     ---                 ³ EVSN
C14  ³ C-12 evasion flux rate from soil (1/sec)         ³ not used  ³ 1.000E-10 ³
     ---                 ³ REVSN
C14  ³ Fraction of grain in beef cattle feed            ³ not used  ³ 8.000E-01 ³
     ---                 ³ AVFG4
C14  ³ Fraction of grain in milk cow feed               ³ not used  ³ 2.000E-01 ³
     ---                 ³ AVFG5
C14  ³ DCF correction factor for gaseous forms of C14   ³ not used  ³ 1.234E+02 ³
     ---                 ³ CO2F
     ³                                                  ³           ³           ³
                         ³
STOR ³ Storage times of contaminated foodstuffs (days): ³           ³           ³
                         ³
STOR ³   Fruits, non-leafy vegetables, and grain        ³ 1.400E+01 ³ 1.400E+01 ³
     ---                 ³ STOR_T(1)
STOR ³   Leafy vegetables                               ³ 1.000E+00 ³ 1.000E+00 ³
     ---                 ³ STOR_T(2)
STOR ³   Milk                                           ³ 1.000E+00 ³ 1.000E+00 ³
     ---                 ³ STOR_T(3)
STOR ³   Meat and poultry                               ³ 2.000E+01 ³ 2.000E+01 ³
     ---                 ³ STOR_T(4)
STOR ³   Fish                                           ³ 7.000E+00 ³ 7.000E+00 ³
     ---                 ³ STOR_T(5)
STOR ³   Crustacea and mollusks                         ³ 7.000E+00 ³ 7.000E+00 ³
     ---                 ³ STOR_T(6)
STOR ³   Well water                                     ³ 1.000E+00 ³ 1.000E+00 ³
     ---                 ³ STOR_T(7)
STOR ³   Surface water                                  ³ 1.000E+00 ³ 1.000E+00 ³
     ---                 ³ STOR_T(8)
STOR ³   Livestock fodder                               ³ 4.500E+01 ³ 4.500E+01 ³
     ---                 ³ STOR_T(9)
     ³                                                  ³           ³           ³
                         ³
R021 ³ Thickness of building foundation (m)             ³ not used  ³ 1.500E-01 ³
     ---                 ³ FLOOR1
R021 ³ Bulk density of building foundation (g/cm**3)    ³ not used  ³ 2.400E+00 ³
     ---                 ³ DENSFL
```

```
 R021 ³ Total porosity of the cover material            ³ not used  ³ 4.000E-01 ³
          ---             ³ TPCV
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 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
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                                          Site-Specific Parameter Summary
(continued)
0     ³                                                 ³   User    ³           ³
      Used by RESRAD          ³  Parameter
 Menu ³                      Parameter                  ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R021 ³ Total porosity of the building foundation       ³ not used  ³ 1.000E-01 ³
          ---             ³ TPFL
 R021 ³ Volumetric water content of the cover material  ³ not used  ³ 5.000E-02 ³
          ---             ³ PH2OCV
 R021 ³ Volumetric water content of the foundation      ³ not used  ³ 3.000E-02 ³
          ---             ³ PH2OFL
 R021 ³ Diffusion coefficient for radon gas (m/sec):    ³           ³           ³
                          ³
 R021 ³   in cover material                             ³ not used  ³ 2.000E-06 ³
          ---             ³ DIFCV
 R021 ³   in foundation material                        ³ not used  ³ 3.000E-07 ³
          ---             ³ DIFFL
 R021 ³   in contaminated zone soil                     ³ not used  ³ 2.000E-06 ³
          ---             ³ DIFCZ
 R021 ³ Radon vertical dimension of mixing (m)          ³ not used  ³ 2.000E+00 ³
          ---             ³ HMIX
 R021 ³ Average building air exchange rate (1/hr)       ³ not used  ³ 5.000E-01 ³
          ---             ³ REXG
 R021 ³ Height of the building (room) (m)               ³ not used  ³ 2.500E+00 ³
          ---             ³ HRM
 R021 ³ Building interior area factor                   ³ not used  ³ 0.000E+00 ³
          ---             ³ FAI
 R021 ³ Building depth below ground surface (m)         ³ not used  ³-1.000E+00 ³
          ---             ³ DMFL
 R021 ³ Emanating power of Rn-222 gas                   ³ not used  ³ 2.500E-01 ³
          ---             ³ EMANA(1)
 R021 ³ Emanating power of Rn-220 gas                   ³ not used  ³ 1.500E-01 ³
          ---             ³ EMANA(2)
      ³                                                 ³           ³           ³
                          ³
 TITL ³ Number of graphical time points                 ³   32      ³    ---    ³
          ---             ³ NPTS
 TITL ³ Maximum number of integration points for dose   ³  17       ³    ---    ³
          ---             ³ LYMAX
 TITL ³ Maximum number of integration points for risk   ³ 257       ³    ---    ³
          ---             ³ KYMAX

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                      Summary of Pathway Selections

                     Pathway             ³   User Selection
           ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
              1 -- external gamma         ³       active
```

```
              2 -- inhalation (w/o radon)³       active
              3 -- plant ingestion       ³     suppressed
              4 -- meat ingestion        ³     suppressed
              5 -- milk ingestion        ³     suppressed
              6 -- aquatic foods         ³     suppressed
              7 -- drinking water        ³     suppressed
              8 -- soil ingestion        ³       active
              9 -- radon                 ³     suppressed
              Find peak pathway doses    ³       active
           ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
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      Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:1400000.00 square meters               Pu-239     7.700E+00
   Thickness:      0.15 meters

 Cover Depth:      0.00 meters
0
                                             Total Dose TDOSE(t), mrem/yr

                                       Basic Radiation Dose Limit =  25 mrem/yr

              Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time
(t)

ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

    t (years):  0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02
3.000E+02  1.000E+03
     TDOSE(t):  1.382E-01  1.381E-01  1.378E-01  1.368E-01  1.341E-01  1.247E-01
1.008E-01  4.147E-02
         M(t):  5.528E-03  5.522E-03  5.511E-03  5.472E-03  5.362E-03  4.990E-03
4.031E-03  1.659E-03
0Maximum TDOSE(t):  1.382E-01 mrem/yr   at t = 0.000E+00 years
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page   9
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                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                             As mrem/yr and Fraction of Total Dose At t =
0.000E+00 years
0                                               Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.638E-05 0.0005  8.687E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.294E-01 0.9367
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 Total   6.638E-05 0.0005  8.687E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.294E-01 0.9367
```

```
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
0.000E+00 years
0                                                       Water Dependent Pathways
0             Water              Fish              Radon              Plant
  Meat               Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.382E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.382E-01 1.0000
0*Sum of all water independent and dependent pathways.
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                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+00 years
0                                          Water Independent Pathways (Inhalation
excludes radon)
0             Ground           Inhalation          Radon              Plant
  Meat               Milk               Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.635E-05 0.0005  8.679E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.293E-01 0.9367
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 Total   6.635E-05 0.0005  8.679E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.293E-01 0.9367
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+00 years
0                                                       Water Dependent Pathways
0             Water              Fish              Radon              Plant
  Meat               Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.381E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.381E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page  11
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t =
3.000E+00 years
0                                      Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.627E-05 0.0005  8.661E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.291E-01 0.9367
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 Total   6.627E-05 0.0005  8.661E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.291E-01 0.9367
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t =
3.000E+00 years
0                                                         Water Dependent Pathways
0              Water             Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.378E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.378E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page  12
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                    As mrem/yr and Fraction of Total Dose At t =
1.000E+01 years
0                                      Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
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 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.601E-05 0.0005  8.600E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.281E-01 0.9367
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 Total   6.601E-05 0.0005  8.600E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.281E-01 0.9367
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+01 years
0                                                       Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.368E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.368E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page  13
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+01 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation           Radon              Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.528E-05 0.0005  8.427E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.256E-01 0.9367
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 Total   6.528E-05 0.0005  8.427E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.256E-01 0.9367
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+01 years
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0                                                          Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.341E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.341E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:21  Page  14
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                          Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                             As mrem/yr and Fraction of Total Dose At t =
1.000E+02 years
0                                               Water Independent Pathways (Inhalation
excludes radon)
0             Ground           Inhalation           Radon              Plant
  Meat              Milk               Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  6.276E-05 0.0005  7.841E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.168E-01 0.9366
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 Total   6.276E-05 0.0005  7.841E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.168E-01 0.9366
0
                          Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                             As mrem/yr and Fraction of Total Dose At t =
1.000E+02 years
0                                                          Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.247E-01 1.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.247E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year       03/16/2006  15:21  Page  15
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 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+02 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground           Inhalation          Radon             Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 Pu-239  5.592E-05 0.0006  6.334E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  9.438E-02 0.9366
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ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 Total   5.592E-05 0.0006  6.334E-03 0.0629  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  9.438E-02 0.9366
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
3.000E+02 years
0                                                     Water Dependent Pathways
0              Water            Fish               Radon             Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.008E-01 1.0000
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  1.008E-01 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page  16
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+03 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground           Inhalation          Radon             Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
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 Pu-239  3.499E-05 0.0008  2.606E-03 0.0628  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.883E-02 0.9363
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 Total   3.499E-05 0.0008  2.606E-03 0.0628  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  3.883E-02 0.9363
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                     As mrem/yr and Fraction of Total Dose At t =
1.000E+03 years
0                                                       Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
 Pu-239  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.147E-02 1.0000
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0.000E+00 0.0000  0.000E+00 0.0000  4.147E-02 1.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page  17
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                                  Dose/Source Ratios Summed Over All Pathways

                       Parent and Progeny Principal Radionuclide Contributions
Indicated
0Parent  Product  Branch                              DSR(j,t)  (mrem/yr)/(pCi/g)

  (i)      (j)   Fraction* t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ    ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
 Pu-239  Pu-239  1.000E+00    1.795E-02 1.793E-02 1.789E-02 1.777E-02 1.741E-02
1.620E-02 1.309E-02 5.385E-03
 Pu-239  U-235   1.000E+00    1.079E-11 2.691E-11 4.358E-11 5.414E-11 5.393E-11
5.162E-11 4.540E-11 2.690E-11
 Pu-239  Pa-231  1.000E+00    3.768E-16 2.326E-15 9.480E-15 4.185E-14 1.145E-13
2.053E-13 1.887E-13 7.952E-14
 Pu-239  Ac-227  1.000E+00    5.917E-18 7.925E-17 7.269E-16 9.308E-15 5.543E-14
1.428E-13 1.400E-13 6.467E-14
 Pu-239  äDSR(j)              1.795E-02 1.793E-02 1.789E-02 1.777E-02 1.741E-02
1.620E-02 1.309E-02 5.385E-03
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ    ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ
ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ
 *Branch Fraction is the cumulative factor for the j't principal radionuclide
daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
 The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

0
                               Single Radionuclide Soil Guidelines G(i,t) in pCi/g

                                  Basic Radiation Dose Limit =  25 mrem/yr
```

```
0Nuclide
   (i)    t= 0.000E+00   1.000E+00   3.000E+00   1.000E+01   3.000E+01   1.000E+02
3.000E+02   1.000E+03
 ÄÄÄÄÄÄÄ     ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
 Pu-239      1.393E+03   1.394E+03   1.397E+03   1.407E+03   1.436E+03   1.543E+03
1.910E+03   4.642E+03
 ÍÍÍÍÍÍÍ     ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ
ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ
0
             Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
             and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
          at tmin = time of minimum single radionuclide soil guideline
      and at tmax = time of maximum total dose = 0.000E+00 years
0Nuclide  Initial        tmin       DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
   (i)     pCi/g        (years)                  (pCi/g)               (pCi/g)
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ
 Pu-239  7.700E+00     0.000E+00      1.795E-02  1.393E+03  1.795E-02  1.393E+03
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ

1RESRAD, Version 6.0      T« Limit = 0.5 year        03/16/2006  15:21  Page  18
 Summary : Wildlife Refuge Visitor Child Surface Soil/Sediment Exposure - Windblown
EU - 2
 File    : WBWRVC.RAD

                               Individual Nuclide Dose Summed Over All Pathways
                                 Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   BRF(i)                                      DOSE(j,t), mrem/yr
   (j)     (i)            t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ    ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
 Pu-239  Pu-239  1.000E+00    1.382E-01 1.381E-01 1.378E-01 1.368E-01 1.341E-01
1.247E-01 1.008E-01 4.147E-02
0U-235   Pu-239  1.000E+00    8.310E-11 2.072E-10 3.355E-10 4.169E-10 4.153E-10
3.975E-10 3.496E-10 2.072E-10
0Pa-231  Pu-239  1.000E+00    2.902E-15 1.791E-14 7.300E-14 3.222E-13 8.814E-13
1.580E-12 1.453E-12 6.123E-13
0Ac-227  Pu-239  1.000E+00    4.556E-17 6.102E-16 5.597E-15 7.167E-14 4.268E-13
1.100E-12 1.078E-12 4.980E-13
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ    ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ
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 BRF(i) is the branch fraction of the parent nuclide.



                                    Individual Nuclide Soil Concentration
                                 Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   BRF(i)                                        S(j,t), pCi/g
   (j)     (i)            t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01
1.000E+02 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ    ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
 Pu-239  Pu-239  1.000E+00    7.700E+00 7.696E+00 7.688E+00 7.661E+00 7.583E+00
7.316E+00 6.603E+00 4.614E+00
0U-235   Pu-239  1.000E+00    0.000E+00 6.091E-09 1.240E-08 1.642E-08 1.643E-08
1.585E-08 1.431E-08 9.997E-09
0Pa-231  Pu-239  1.000E+00    0.000E+00 6.878E-14 4.690E-13 2.513E-12 7.247E-12
1.361E-11 1.394E-11 9.757E-12
0Ac-227  Pu-239  1.000E+00    0.000E+00 7.417E-16 1.548E-14 2.720E-13 1.768E-12
4.780E-12 5.128E-12 3.590E-12
 ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ    ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ
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 BRF(i) is the branch fraction of the parent nuclide.
0RESMAIN5.EXE execution time =    0.81 seconds
```

## 3.0 ECOLOGICAL RISK ASSESSMENT TABLES

# TABLES

**Table A4.1.1**

**Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Worker using Tier 1 EPCs**

| Exposure Route | Contaminant of Concern | Tier 1 EPC (mg/kg) | Cancer Risk Calculations | | | Non-Cancer Hazard Calculations | | |
|---|---|---|---|---|---|---|---|---|
| | | | Intake/Exposure Concentration (mg/kg/day) | CSF (mg/kg/day)-1 | Cancer Risk | Intake/Exposure Concentration (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient |
| **Surface Soil/Surface Sediment** | | | | | | | | |
| Ingestion | Arsenic | 5.50 | 1.32E-06 | 1.5E+00 | 2.0E-06 | 4.95E-06 | 3.00E-04 | 0.016 |
| | | | | **Ingestion Total:** | **2E-06** | | **Ingestion Total:** | **0.02** |
| | | | | | | | | |
| Inhalation - (indoor + outdoor) | Arsenic | 5.50 | 7.83E-09 | 1.5E+01 | 1.2E-07 | 2.93E-08 | N/A | NC |
| | | | | **Inhalation Total:** | **1E-07** | | **Inhalation Total:** | **0** |
| | | | | | | | | |
| Dermal | Arsenic | 5.50 | -- | N/A | NC | -- | N/A | NC |
| | | | | **Dermal Total:** | **0** | | **Dermal Total:** | **0** |
| | | | | **Surface Soil/Surface Sediment Total:** | **2E-06** | | **Surface Soil/Surface Sediment Total:** | **0.02** |
| | | | | | | | | |
| | | | | **WRW Total:** | **2E-06** | | **WRW Total:** | **0.02** |

N/A = Not applicable or not available.

NC = Not calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology.

-- = Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

**Table A4.1.2**
**Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Worker using Tier 1 EPCs**

| Medium/ Exposure Route | Contaminant of Concern | Tier 1 EPC (pCi/g) | Cancer Risk Calculations | | | | |
|---|---|---|---|---|---|---|---|
| | | | Intake/Activity | | CSF | | Cancer Risk |
| | | | Value | Units | Value | Units | |
| **Surface Soil/Surface Sediment** | | | | | | | |
| Ingestion | Plutonium-239/240 | 12.12 | 5,214 | pCi | 1.21E-10 | risk/pCi | 6.31E-07 |
| | | | | | | **Ingestion Total:** | **6E-07** |
| | | | | | | | |
| Inhalation | Plutonium-239/240 | 12.12 | 30.88 | pCi | 3.33E-08 | risk/pCi | 1.03E-06 |
| | | | | | | **Inhalation Total:** | **1E-06** |
| | | | | | | | |
| External | Plutonium-239/240 | 12.12 | 30.00 | pCi-yr/g | 2.00E-10 | (risk/yr)/(pCi/g) | 6.00E-09 |
| | | | | | | **External Total:** | **6E-09** |
| | | | | | | | |
| Combined | Plutonium-239/240 | | | | | | 1.67E-06 |
| | | | | | | **Surface Soil/Surface Sediment Total:** | **2E-06** |
| | | | | | | **Tier 1 WRW Total:** | **2E-06** |

**Table A4.1.3**
**Calculation of Radiation Dose for the Wildlife Refuge Worker using Tier 1 EPCs**

| Exposure Route | Contaminant of Concern | Tier 1 EPC (pCi/g) | RESRAD Radiation Dose Time = 0 (mrem) |
|---|---|---|---|
| **Surface Soil/Surface Sediment** | | | |
| Ingestion | Plutonium-239/240 | 12.1 | 0.281 |
| | | **Ingestion Total:** | **3E-01** |
| | | | |
| Inhalation | Plutonium-239/240 | 12.1 | 0.058 |
| | | **Inhalation Total:** | **6E-02** |
| | | | |
| External | Plutonium-239/240 | 12.1 | 5.55E-04 |
| | | **External Total:** | **6E-04** |
| | | | |
| | | **Surface Soil/Surface Sediment Total:** | **3E-01** |
| | | **Tier 1 WRW Total:** | **3E-01** |

**Table A4.1.4**

**Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Worker using Tier 2 EPCs**

| Exposure Route | Contaminant of Concern | Tier 2 EPC (mg/kg) | Cancer Risk Calculations | | | Non-Cancer Hazard Calculations | | |
|---|---|---|---|---|---|---|---|---|
| | | | Intake/Exposure Concentration (mg/kg/day) | CSF (mg/kg/day)-1 | Cancer Risk | Intake/Exposure Concentration (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient |
| **Surface Soil/Surface Sediment** | | | | | | | | |
| Ingestion | Arsenic | 4.69 | 1.13E-06 | 1.5E+00 | 1.7E-06 | 4.22E-06 | 3.00E-04 | 0.014 |
| | | | | **Ingestion Total:** | **2E-06** | | **Ingestion Total:** | **0.01** |
| | | | | | | | | |
| Inhalation - (indoor + outdoor) | Arsenic | 4.69 | 6.68E-09 | 1.5E+01 | 1.0E-07 | 2.50E-08 | N/A | NC |
| | | | | **Inhalation Total:** | **1E-07** | | **Inhalation Total:** | **0** |
| | | | | | | | | |
| Dermal | Arsenic | 4.69 | -- | N/A | NC | -- | N/A | NC |
| | | | | **Dermal Total:** | **0** | | **Dermal Total:** | **0** |
| | | | | **Surface Soil/Surface Sediment Total:** | **2E-06** | | **Surface Soil/Surface Sediment Total:** | **0.01** |
| | | | | | | | | |
| | | | | **WRW Total:** | **2E-06** | | **WRW Total:** | **0.01** |

N/A = Not applicable or not available.

NC = Not calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology.

-- = Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

**Table A4.1.5**
**Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Worker using Tier 2 EPCs**

| Exposure Route | Contaminant of Concern | Tier 2 EPC (pCi/g) | Cancer Risk Calculations | | | | |
|---|---|---|---|---|---|---|---|
| | | | Intake/Activity | | CSF | | Cancer Risk |
| | | | Value | Units | Value | Units | |
| **Surface Soil/Surface Sediment** | | | | | | | |
| Ingestion | Plutonium-239/240 | 6.76 | 2,907 | pCi | 1.21E-10 | risk/pCi | 3.52E-07 |
| | | | | | | **Ingestion Total:** | **4E-07** |
| | | | | | | | |
| Inhalation - (indoor + outdoor) | Plutonium-239/240 | 6.76 | 17.22 | pCi | 3.33E-08 | risk/pCi | 5.73E-07 |
| | | | | | | **Inhalation Total:** | **6E-07** |
| | | | | | | | |
| External | Plutonium-239/240 | 6.76 | 16.73 | (pCi-yr)/g | 2.00E-10 | (risk/yr)/(pCi/g) | 3.35E-09 |
| | | | | | | **External Total:** | **3E-09** |
| | | | | | | | |
| Combined | Plutonium-239/240 | | | | | | 9.29E-07 |
| | | | | | | **Surface Soil/Surface Sediment Total:** | **9E-07** |
| | | | | | | **Tier 2 WRW Total:** | **9E-07** |

**Table A4.1.6**
**Calculation of Radiation Dose for the Wildlife Refuge Worker using Tier 2 EPCs**

| Medium/ Exposure Route | Contaminant of Concern | Tier 2 EPC (pCi/g) | RESRAD Radiation Dose Time = 0 (mrem) |
|---|---|---|---|
| **Surface Soil/Surface Sediment** | | | |
| Ingestion | Plutonium-239/240 | 6.76 | 0.179 |
| | | **Ingestion Total:** | 1.8E-01 |
| | | | |
| Inhalation | Plutonium-239/240 | 6.76 | 0.037 |
| | | **Inhalation Total:** | 3.7E-02 |
| | | | |
| External | Plutonium-239/240 | 6.76 | 3.5E-04 |
| | | **External Total:** | 3.5E-04 |
| | | | |
| | | **Surface Soil/Surface Sediment Total:** | 0.216 |
| | | **Tier 2 WRW Total:** | 2.2E-01 |

**Table A4.1.7**

**Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Visitor using Tier 1 EPCs**

| Exposure Route | Contaminant of Concern | Tier 1 EPC (mg/kg) | Cancer Risk Calculations | | | Non-Cancer Hazard Calculations | | |
|---|---|---|---|---|---|---|---|---|
| | | | Intake/Exposure Concentration (mg/kg/day) | CSF (mg/kg/day)-1 | Cancer Risk | Intake/Exposure Concentration (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient |
| **Surface Soil/Surface Sediment** | | | | | | | | |
| Ingestion | Arsenic | 5.50 | 1.23E-06 | 1.5E+00 | 1.8E-06 | 2.87E-06 | 3.00E-04 | 0.010 |
| | | | | **Ingestion Total:** | **2E-06** | | **Ingestion Total:** | **0.01** |
| | | | | | | | | |
| Inhalation - (outdoor) | Arsenic | 5.50 | 5.27E-09 | 1.5E+01 | 8.0E-08 | 1.23E-08 | N/A | NC |
| | | | | **Inhalation Total:** | **8E-08** | | **Inhalation Total:** | **0** |
| | | | | | | | | |
| Dermal | Arsenic | 5.50 | -- | N/A | NC | -- | N/A | NC |
| | | | | **Dermal Total:** | **0** | | **Dermal Total:** | **0** |
| | | | | **Surface Soil/Surface Sediment Total:** | **2E-06** | | **Surface Soil/Surface Sediment Total:** | **0.01** |
| | | | | | | | | |
| | | | | **WRV Total:** | **2E-06** | | **WRV Total:** | **0.01** |

N/A = Not applicable or not available.

NC = Not Calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology.

-- = Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

**Table A4.1.8**

**Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Visitor using Tier 1 EPCs**

| Exposure Route | Contaminant of Concern | Tier 1 EPC (pCi/g) | Cancer Risk Calculations | | | | |
|---|---|---|---|---|---|---|---|
| | | | Intake/Activity | | CSF | | Cancer Risk |
| | | | Value | Units | Value | Units | |
| **Surface Soil/Surface Sediment** | | | | | | | |
| Ingestion | Plutonium-239/240 | 12.1 | 2,182 | pCi | 2.76E-10 | risk/pCi | 6.02E-07 |
| | | | | | | **Ingestion Total:** | **6E-07** |
| | | | | | | | |
| Inhalation - (outdoor) | Plutonium-239/240 | 12.1 | 13.40 | pCi | 3.33E-08 | risk/pCi | 4.46E-07 |
| | | | | | | **Inhalation Total:** | **4E-07** |
| | | | | | | | |
| External | Plutonium-239/240 | 12.1 | 9.34 | (pCi-yr)/g | 2.00E-10 | (risk/yr)/(pCi/g) | 1.87E-09 |
| | | | | | | **External Total:** | **2E-09** |
| | | | | | | | |
| Combined | Plutonium-239/240 | | | | | | 1.05E-06 |
| | | | | | | **Surface Soil/Surface Sediment Total:** | **1E-06** |
| | | | | | | **Tier 1 WRV Total:** | **1E-06** |

**Table A4.1.9**

**Calculation of Radiation Dose for the Wildlife Refuge Visitor using Tier 1 EPCs**

| Medium/ Exposure Route | Contaminant of Concern | Tier 1 EPC (pCi/g) | RESRAD Radiation Dose Adult Receptor Time = 0 (mrem) | RESRAD Radiation Dose Child Receptor Time = 0 (mrem) |
|---|---|---|---|---|
| **Surface Soil/Surface Sediment** | | | | |
| Ingestion | Plutonium-239/240 | 12.1 | 0.059 | 0.203 |
| | | **Ingestion Total:** | **5.9E-02** | **2.0E-01** |
| | | | | |
| Inhalation | Plutonium-239/240 | 12.1 | 0.013 | 0.014 |
| | | **Inhalation Total:** | **1.3E-02** | **1.4E-02** |
| | | | | |
| External | Plutonium-239/240 | 12.1 | 1.04E-04 | 1.04E-04 |
| | | **External Total:** | **1.0E-04** | **1.0E-04** |
| | | | | |
| | | **Surface Soil/Surface Sediment Total:** | **7.2E-02** | **2.2E-01** |
| | | **Tier 1 WRV Total:** | **7.2E-02** | **2.2E-01** |
| | | | | |

**Table A4.1.10**

**Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Visitor using Tier 2 EPCs**

| Exposure Route | Contaminant of Concern | Tier 2 EPC (mg/kg) | Cancer Risk Calculations | | | Non-Cancer Hazard Calculations | | |
|---|---|---|---|---|---|---|---|---|
| | | | Intake/Exposure Concentration (mg/kg/day) | CSF (mg/kg/day)-1 | Cancer Risk | Intake/Exposure Concentration (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient |
| **Surface Soil/Surface Sediment** | | | | | | | | |
| Ingestion | Arsenic | 4.69 | 1.05E-06 | 1.5E+00 | 1.6E-06 | 2.45E-06 | 0.000 | 0.008 |
| | | | | **Ingestion Total:** | **2E-06** | | **Ingestion Total:** | **0.01** |
| | | | | | | | | |
| Inhalation - (outdoor) | Arsenic | 4.69 | 4.50E-09 | 1.5E+01 | 6.8E-08 | 1.05E-08 | N/A | NC |
| | | | | **Inhalation Total:** | **7E-08** | | **Inhalation Total:** | **0** |
| | | | | | | | | |
| Dermal | Arsenic | 4.69 | -- | N/A | NC | -- | N/A | NC |
| | | | | **Dermal Total:** | **0** | | **Dermal Total:** | **0** |
| | | | | **Surface Soil/Surface Sediment Total:** | **2E-06** | | **Surface Soil/Surface Sediment Total:** | **0.008** |
| | | | | | | | | |
| | | | | **WRV Total:** | **2E-06** | | **WRV Total:** | **0.008** |

N/A = Not applicable or not available.

NC = Not calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology.

-- = Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

**Table A4.1.11**
**Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Visitor using Tier 2 EPCs**

| Exposure Route | Contaminant of Concern | Tier 2 EPC (pCi/g) | Cancer Risk Calculations | | | | |
|---|---|---|---|---|---|---|---|
| | | | Intake/Activity | | CSF | | Cancer Risk |
| | | | Value | Units | Value | Units | |
| **Surface Soil/Surface Sediment** | | | | | | | |
| Ingestion | Plutonium-239/240 | 6.76 | 1217 | pCi | 2.76E-10 | risk/pCi | 3.36E-07 |
| | | | | | | **Ingestion Total:** | **3E-07** |
| | | | | | | | |
| Inhalation - (outdoor) | Plutonium-239/240 | 6.76 | 7.47 | pCi | 3.33E-08 | risk/pCi | 2.49E-07 |
| | | | | | | **Inhalation Total:** | **2E-07** |
| | | | | | | | |
| External | Plutonium-239/240 | 6.76 | 5.21 | (pCi-yr)/g | 2.00E-10 | (risk/yr)/(pCi/g) | 1.04E-09 |
| | | | | | | **External Total:** | **1E-09** |
| | | | | | | | |
| Combined | Plutonium-239/240 | | | | | | 5.86E-07 |
| | **Surface Soil/Surface Sediment Total:** | | | | | | **6E-07** |
| **Tier 2 WRV Total:** | | | | | | | **6E-07** |

**Table A4.1.12**
**Calculation of Radiation Dose for the Wildlife Refuge Visitor using Tier 2 EPCs**

| Exposure Route | Contaminant of Concern | Tier 2 EPC (pCi/g) | RESRAD Radiation Dose Adult Receptor Time = 0 (mrem) | RESRAD Radiation Dose Child Receptor Time = 0 (mrem) |
|---|---|---|---|---|
| **Surface Soil/Surface Sediment** | | | | |
| Ingestion | Plutonium-239/240 | 6.76 | 0.0376 | 0.1294 |
| | | **Ingestion Total:** | **3.8E-02** | **1.3E-01** |
| | | | | |
| Inhalation | Plutonium-239/240 | 6.76 | 0.00813 | 0.00869 |
| | | **Inhalation Total:** | **8.1E-03** | **8.7E-03** |
| | | | | |
| External | Plutonium-239/240 | 6.76 | 6.64E-05 | 6.64E-05 |
| | | **External Total:** | **6.6E-05** | **6.6E-05** |
| | | | | |
| | | **Surface Soil/Surface Sediment Total:** | **0.0458** | **0.138** |
| | | **Tier 2 WRV Total:** | **4.6E-02** | **1.4E-01** |
| | | | | |

**Table A4.3.1**
**Non-PMJM Intake Estimates for Chromium in WBEU Surface Soils; Default Exposure Scenario**

| **Bioaccumulation Factors** | | | | | | |
|---|---|---|---|---|---|---|
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| 0.084 | 3.162 | lnCm = -1.495 + 0.7326(lnCs) | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 31 | Tier 1 UTL | 2.60 | 98.0 | 2.78 | 0.019 | |
| 20.2 | Tier 1 UCL | 1.70 | 63.9 | 2.03 | 0.003 | |
| 22.6 | Tier 2 UTL | 1.90 | 71.5 | 2.20 | 0.019 | |
| 15.1 | Tier 2 UCL | 1.27 | 47.7 | 1.64 | 0.003 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$ (kg/kg BW day)** | **$IR_{(water)}$ (kg/kg BW day)** | **$IR_{(soil)}$ (kg/kg BW day)** | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Mourning Dove - Herbivore | 0.23 | 0.12 | 0.021 | 1 | 0 | 0 |
| Mourning Dove - Insectivore | 0.23 | 0.12 | 0.021 | 0 | 1 | 0 |
| American Kestrel | 0.092 | 0.12 | 0.005 | 0 | 0.2 | 0.8 |
| Deer Mouse - Insectivore | 0.065 | 0.19 | 0.001 | 0 | 1 | 0 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Mourning Dove - Herbivore* | | | | | | |
| Tier 1 UTL | 0.599 | N/A | N/A | 0.663 | 0.00228 | 1.26 |
| Tier 1 UCL | 0.390 | N/A | N/A | 0.432 | 3.60E-04 | 0.823 |
| Tier 2 UTL | 0.437 | N/A | N/A | 0.483 | 0.00228 | 0.922 |
| Tier 2 UCL | 0.292 | N/A | N/A | 0.323 | 3.60E-04 | 0.615 |
| *Mourning Dove - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 22.5 | N/A | 0.663 | 0.00228 | 23.2 |
| Tier 1 UCL | N/A | 14.7 | N/A | 0.432 | 3.60E-04 | 15.1 |
| Tier 2 UTL | N/A | 16.4 | N/A | 0.483 | 0.00228 | 16.9 |
| Tier 2 UCL | N/A | 11.0 | N/A | 0.323 | 3.60E-04 | 11.3 |
| *American Kestrel* | | | | | | |
| Tier 1 UTL | N/A | 1.80 | 0.204 | 0.143 | 0.00228 | 2.15 |
| Tier 1 UCL | N/A | 1.18 | 0.149 | 0.0929 | 3.60E-04 | 1.42 |
| Tier 2 UTL | N/A | 1.31 | 0.162 | 0.104 | 0.00228 | 1.58 |
| Tier 2 UCL | N/A | 0.879 | 0.121 | 0.0695 | 3.60E-04 | 1.07 |
| *Deer Mouse - Insectivore* | | | | | | |

**Table A4.3.2**
**Non-PMJM Intake Estimates for Chromium in WBEU Surface Soils; Alternative Exposure Scenario**

| **Bioaccumulation Factors** | | | | | | |
|---|---|---|---|---|---|---|
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| 0.041 | 0.306 | lnCm = -1.495 + 0.7326(lnCs) | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 31 | Tier 1 UTL | 1.27 | 9.5 | 2.78 | 0.019 | |
| 20.2 | Tier 1 UCL | 0.83 | 6.2 | 2.03 | 0.003 | |
| 22.6 | Tier 2 UTL | 0.93 | 6.9 | 2.20 | 0.019 | |
| 15.1 | Tier 2 UCL | 0.62 | 4.6 | 1.64 | 0.003 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$** (kg/kg BW day) | **$IR_{(water)}$** (kg/kg BW day) | **$IR_{(soil)}$** (kg/kg BW day) | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Mourning Dove - Insectivore | 0.23 | 0.12 | 0.021 | 0 | 1 | 0 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Mourning Dove - Insectivore* | | | | | | |
| Tier 1 UTL | NA | 2.18 | NA | 0.663 | 0.00228 | 2.85 |
| Tier 1 UCL | NA | 1.42 | NA | 0.432 | 3.60E-04 | 1.85 |
| Tier 2 UTL | NA | 1.59 | NA | 0.483 | 0.00228 | 2.08 |
| Tier 2 UCL | NA | 1.06 | NA | 0.323 | 3.60E-04 | 1.39 |

N/A = Not applicable.

**Table A4.3.3**
**Terrestrial Plant and Invertebrate Hazard Quotients for Chromium in WBEU Surface Soils**

| Receptor/ EPC Statistic | Concentration (mg/kg) | TRV (mg/kg) | | | Hazard Quotients | | |
|---|---|---|---|---|---|---|---|
| | | Screening ESL | Alternate NOEC | Alternate LOEC | Screening ESL | Alternate NOEC | Alternate LOEC |
| *Terrestrial Plant* | | | | | | | |
| Tier 1 UTL | 31 | 1 | 10 | 30 | **31** | **3** | 1 |
| Tier 1 UCL | 20.2 | 1 | 10 | 30 | **20** | **2** | 0.7 |
| Tier 2 UTL | 22.6 | 1 | 10 | 30 | **23** | 1 | 0.5 |
| Tier 2 UCL | 15.1 | 1 | 10 | 30 | **15** | 1 | 0.5 |
| *Terrestrial Invertebrate* | | | | | | | |
| Tier 1 UTL | 31 | 0.4 | N/A | 32.64 | **78** | N/A | 0.9 |
| Tier 1 UCL | 20.2 | 0.4 | N/A | 32.64 | **51** | N/A | 0.6 |
| Tier 2 UTL | 22.6 | 0.4 | N/A | 32.64 | **57** | N/A | 0.4 |
| Tier 2 UCL | 15.1 | 0.4 | N/A | 32.64 | **38** | N/A | 0.4 |

N/A = Not applicable.

**Table A4.3.4**
**Non-PMJM Terrestrial Plant Hazard Quotients and Invertebrate Hazard Quotients for Chromium in WBEU Surface Soils**

| Receptor/ EPC Statistic | | TRV (mg/kg BW day) | | | | Hazard Quotients | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total Intake (mg/kg BW day) | Chromium (VI) NOAEL | Chromium VI LOAEL | Chromium (III) NOAEL | Chromium III LOAEL | Chromium (VI) NOAEL | Chromium (VI) LOAEL | Chromium (III) NOAEL | Chromium (III) LOAEL |
| **Chromium (Default Exposure)** | | | | | | | | | |
| *Mourning Dove - Herbivore* | | | | | | | | | |
| Tier 1 UTL | 1.26 | N/A | N/A | 1 | 5 | N/A | N/A | **1** | 0.3 |
| Tier 1 UCL | 0.823 | N/A | N/A | 1 | 5 | N/A | N/A | 0.8 | 0.2 |
| Tier 2 UTL | 0.922 | N/A | N/A | 1 | 5 | N/A | N/A | 0.9 | 0.2 |
| Tier 2 UCL | 0.615 | N/A | N/A | 1 | 5 | N/A | N/A | 0.6 | 0.1 |
| *Mourning Dove - Insectivore* | | | | | | | | | |
| Tier 1 UTL | 23.2 | N/A | N/A | 1 | 5 | N/A | N/A | **23** | **5** |
| Tier 1 UCL | 15.1 | N/A | N/A | 1 | 5 | N/A | N/A | **15** | **3** |
| Tier 2 UTL | 16.9 | N/A | N/A | 1 | 5 | N/A | N/A | **17** | **3** |
| Tier 2 UCL | 11.3 | N/A | N/A | 1 | 5 | N/A | N/A | **11** | **2** |
| *American Kestrel* | | | | | | | | | |
| Tier 1 UTL | 2.15 | N/A | N/A | 1 | 5 | N/A | N/A | **2** | 0.4 |
| Tier 1 UCL | 1.42 | N/A | N/A | 1 | 5 | N/A | N/A | 1 | 0.3 |
| Tier 2 UTL | 1.58 | N/A | N/A | 1 | 5 | N/A | N/A | **2** | 0.3 |
| Tier 2 UCL | 1.07 | N/A | N/A | 1 | 5 | N/A | N/A | 1 | 0.2 |
| *Deer Mouse - Insectivore* | | | | | | | | | |
| Tier 1 UTL | 6.42 | 3.28 | 13.1 | 2,737 | N/A | **2** | 0.5 | 0.002 | N/A |
| Tier 1 UCL | 4.18 | 3.28 | 13.1 | 2,737 | N/A | 1 | 0.3 | 0.002 | N/A |
| Tier 2 UTL | 4.68 | 3.28 | 13.1 | 2,737 | N/A | 1 | 0.4 | 0.002 | N/A |
| Tier 2 UCL | 3.12 | 3.28 | 13.1 | 2,737 | N/A | 0.95 | 0.2 | 0.001 | N/A |
| **Chromium (Alternative Exposure Scenario; Median BAFs)** | | | | | | | | | |
| *Mourning Dove - Insectivore* | | | | | | | | | |
| Tier 1 UTL | 2.85 | N/A | N/A | 1 | 5 | N/A | N/A | **3** | 0.6 |
| Tier 1 UCL | 1.85 | N/A | N/A | 1 | 5 | N/A | N/A | **2** | 0.4 |
| Tier 2 UTL | 2.08 | N/A | N/A | 1 | 5 | N/A | N/A | **2** | 0.4 |
| Tier 2 UCL | 1.39 | N/A | N/A | 1 | 5 | N/A | N/A | 1 | 0.3 |

N/A = Not applicable.
**Bold = Hazard Quotients greater than 1.**

**Table A4.3.5**
**Non-PMJM Intake Estimates for Manganese in WBEU Surface Soils; Default Exposure Scenario**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Bioaccumulation Factors** | | | | | | |
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| 0.234 | lnCi = 0.809 + 0.682(lnCs) | 0.037 | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 490 | Tier 1 UTL | 114.66 | 153.5 | 18.13 | 0.19 | |
| 336 | Tier 1 UCL | 78.62 | 118.7 | 12.43 | 0.093 | |
| 583 | Tier 2 UTL | 136.42 | 172.8 | 21.57 | 0.19 | |
| 340 | Tier 2 UCL | 79.56 | 119.6 | 12.58 | 0.093 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$ (kg/kg BW day)** | **$IR_{(water)}$ (kg/kg BW day)** | **$IR_{(soil)}$ (kg/kg BW day)** | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Deer Mouse - Herbivore | 0.111 | 0.19 | 0.002 | 1 | 0 | 0 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Deer Mouse - Herbivore* | | | | | | |
| Tier 1 UTL | 12.7 | N/A | N/A | 1.09 | 0.0361 | 13.9 |
| Tier 1 UCL | 8.73 | N/A | N/A | 0.746 | 0.0177 | 9.49 |
| Tier 2 UTL | 15.1 | N/A | N/A | 1.29 | 0.0361 | 16.5 |
| Tier 2 UCL | 8.83 | N/A | N/A | 0.755 | 0.0177 | 9.60 |

**Table A4.3.6**
**Non-PMJM Hazard Quotients for Manganese in WBEU Surface Soils**

| Receptor/ EPC Statistic | Total Intake (mg/kg BW day) | TRV (mg/kg BW day) | | Hazard Quotients | |
|---|---|---|---|---|---|
| | | NOAEL | LOAEL | NOAEL | LOAEL |
| **Manganese (Default Exposure)** | | | | | |
| *Deer Mouse - Herbivore* | | | | | |
| Tier 1 UTL | 13.9 | 13.3 | 159.1 | 1 | 0.09 |
| Tier 1 UCL | 9.49 | 13.3 | 159.1 | 0.7 | 0.06 |
| Tier 2 UTL | 16.5 | 13.3 | 159.1 | 1 | 0.1 |
| Tier 2 UCL | 9.60 | 13.3 | 159.1 | 0.7 | 0.06 |

N/A = Not applicable.

**Table A4.3.7**
**Non-PMJM Intake Estimates for Nickel in WBEU Surface Soils; Default Exposure Scenario**

| **Bioaccumulation Factors** | | | | | | |
|---|---|---|---|---|---|---|
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| lnCp = -2.224+0.748(lnCs) | 4.73 | lnCm = -0.2462 + 0.4658(lnCs) | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 25.6 | Tier 1 UTL | 1.22 | 121.1 | 3.54 | 0.012 | |
| 16 | Tier 1 UCL | 0.86 | 75.7 | 2.84 | 0.008 | |
| 18.3 | Tier 2 UTL | 0.95 | 86.6 | 3.03 | 0.012 | |
| 13.7 | Tier 2 UCL | 0.77 | 64.8 | 2.65 | 0.008 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$** (kg/kg BW day) | **$IR_{(water)}$** (kg/kg BW day) | **$IR_{(soil)}$** (kg/kg BW day) | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Mourning Dove - Insectivore | 0.23 | 0.12 | 0.021 | 0 | 1 | 0 |
| Deer Mouse - Herbivore | 0.111 | 0.19 | 0.002 | 1 | 0 | 0 |
| Deer Mouse - Insectivore | 0.065 | 0.19 | 0.001 | 0 | 1 | 0 |
| Coyote - Generalist | 0.015 | 0.08 | 0.001 | 0 | 0.25 | 0.75 |
| Coyote - Insectivore | 0.015 | 0.08 | 0.0004 | 0 | 1 | 0 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Mourning Dove - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 27.9 | N/A | 0.548 | 0.00144 | 28.4 |
| Tier 1 UCL | N/A | 17.4 | N/A | 0.342 | 9.60E-04 | 17.7 |
| Tier 2 UTL | N/A | 19.9 | N/A | 0.391 | 0.00144 | 20.3 |
| Tier 2 UCL | N/A | 14.9 | N/A | 0.293 | 9.60E-04 | 15.2 |
| *Deer Mouse - Herbivore* | | | | | | |
| Tier 1 UTL | 0.136 | N/A | N/A | 0.0568 | 0.00228 | 0.195 |
| Tier 1 UCL | 0.0955 | N/A | N/A | 0.0355 | 0.00152 | 0.133 |
| Tier 2 UTL | 0.106 | N/A | N/A | 0.0406 | 0.00228 | 0.149 |
| Tier 2 UCL | 0.0851 | N/A | N/A | 0.0304 | 0.00152 | 0.117 |
| *Deer Mouse - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 7.87 | N/A | 0.0333 | 0.00228 | 7.91 |
| Tier 1 UCL | N/A | 4.92 | N/A | 0.0208 | 0.00152 | 4.94 |
| Tier 2 UTL | N/A | 5.63 | N/A | 0.0238 | 0.00228 | 5.65 |
| Tier 2 UCL | N/A | 4.21 | N/A | 0.0178 | 0.00152 | 4.23 |
| *Coyote - Generalist* | | | | | | |
| Tier 1 UTL | N/A | 0.454 | 0.0398 | 0.0192 | 9.60E-04 | 0.514 |
| Tier 1 UCL | N/A | 0.284 | 0.0320 | 0.0120 | 6.40E-04 | 0.328 |
| Tier 2 UTL | N/A | 0.325 | 0.0341 | 0.0137 | 9.60E-04 | 0.373 |
| Tier 2 UCL | N/A | 0.243 | 0.0298 | 0.0103 | 6.40E-04 | 0.284 |
| *Coyote - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 1.82 | N/A | 0.0108 | 9.60E-04 | 1.83 |
| Tier 1 UCL | N/A | 1.14 | N/A | 0.00672 | 6.40E-04 | 1.14 |
| Tier 2 UTL | N/A | 1.30 | N/A | 0.00769 | 9.60E-04 | 1.31 |
| Tier 2 UCL | N/A | 0.972 | N/A | 0.00575 | 6.40E-04 | 0.978 |

N/A = Not applicable.

**Table A4.3.8**
**Non-PMJM Intake Estimates for Nickel in WBEU Surface Soils; Alternative Exposure Scenario**

| **Bioaccumulation Factors** | | | | | | |
|---|---|---|---|---|---|---|
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| $\ln Cp = -2.224+0.748(\ln Cs)$ | 1.059 | $\ln Cm = -0.2462 + 0.4658(\ln Cs)$ | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 25.6 | Tier 1 UTL | 1.22 | 27.1 | 3.54 | 0.012 | |
| 16 | Tier 1 UCL | 0.86 | 16.9 | 2.84 | 0.008 | |
| 18.3 | Tier 2 UTL | 0.95 | 19.4 | 3.03 | 0.012 | |
| 13.7 | Tier 2 UCL | 0.77 | 14.5 | 2.65 | 0.008 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$ (kg/kg BW day)** | **$IR_{(water)}$ (kg/kg BW day)** | **$IR_{(soil)}$ (kg/kg BW day)** | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Deer Mouse - Insectivore | 0.065 | 0.19 | 0.001 | 0 | 1 | 0 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Deer Mouse - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 1.76 | N/A | 0.0333 | 0.00228 | 1.80 |
| Tier 1 UCL | N/A | 1.10 | N/A | 0.0208 | 0.00152 | 1.12 |
| Tier 2 UTL | N/A | 1.26 | N/A | 0.0238 | 0.00228 | 1.29 |
| Tier 2 UCL | N/A | 0.943 | N/A | 0.0178 | 0.00152 | 0.962 |

N/A = Not applicable.

## Table A4.3.9
## Non-PMJM Hazard Quotients for Nickel in WBEU Surface Soils

| Receptor/ EPC Statistic | Total Intake (mg/kg BW day) | TRV (mg/kg BW day) | | | | Hazard Quotients | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | NOAEL | LOAEL | Sample et al. (1996) NOAEL | Sample et al. (1996) LOAEL | NOAEL | LOAEL | Sample et al. (1996) NOAEL | Sample et al. (1996) LOAEL |
| **Nickel (Default Exposure)** | | | | | | | | | |
| *Mourning Dove - Insectivore* | | | | | | | | | |
| Tier 1 UTL | 28.4 | 1.38 | 55.3 | 77.4 | 107 | **21** | 0.5 | 0.4 | 0.01 |
| Tier 1 UCL | 17.7 | 1.38 | 55.3 | 77.4 | 107 | **13** | 0.3 | 0.2 | 0.01 |
| Tier 2 UTL | 20.3 | 1.38 | 55.3 | 77.4 | 107 | **15** | 0.4 | 0.3 | 0.01 |
| Tier 2 UCL | 15.2 | 1.38 | 55.3 | 77.4 | 107 | **11** | 0.3 | 0.2 | 0.01 |
| *Deer Mouse - Herbivore* | | | | | | | | | |
| Tier 1 UTL | 0.195 | 0.133 | 1.33 | 40 | 80 | 1 | 0.1 | 0.005 | 0.002 |
| Tier 1 UCL | 0.133 | 0.133 | 1.33 | 40 | 80 | 0.997 | 0.1 | 0.003 | 0.002 |
| Tier 2 UTL | 0.149 | 0.133 | 1.33 | 40 | 80 | 1 | 0.1 | 0.004 | 0.002 |
| Tier 2 UCL | 0.117 | 0.133 | 1.33 | 40 | 80 | 0.9 | 0.1 | 0.003 | 0.001 |
| *Deer Mouse - Insectivore* | | | | | | | | | |
| Tier 1 UTL | 7.91 | 0.133 | 1.33 | 40 | 80 | **59** | **6** | 0.2 | 0.10 |
| Tier 1 UCL | 4.94 | 0.133 | 1.33 | 40 | 80 | **37** | **4** | 0.1 | 0.06 |
| Tier 2 UTL | 5.65 | 0.133 | 1.33 | 40 | 80 | **42** | **4** | 0.1 | 0.07 |
| Tier 2 UCL | 4.23 | 0.133 | 1.33 | 40 | 80 | **32** | **3** | 0.1 | 0.05 |
| *Coyote - Generalist* | | | | | | | | | |
| Tier 1 UTL | 0.514 | 0.133 | 1.33 | 40 | 80 | **4** | 0.4 | 0.01 | 0.01 |
| Tier 1 UCL | 0.328 | 0.133 | 1.33 | 40 | 80 | **2** | 0.2 | 0.01 | 0.00 |
| Tier 2 UTL | 0.373 | 0.133 | 1.33 | 40 | 80 | **3** | 0.3 | 0.01 | 0.00 |
| Tier 2 UCL | 0.284 | 0.133 | 1.33 | 40 | 80 | **2** | 0.2 | 0.01 | 0.00 |
| *Coyote - Insectivore* | | | | | | | | | |
| Tier 1 UTL | 1.83 | 0.133 | 1.33 | 40 | 80 | **14** | 1 | 0.05 | 0.02 |
| Tier 1 UCL | 1.14 | 0.133 | 1.33 | 40 | 80 | **9** | 0.9 | 0.03 | 0.01 |
| Tier 2 UTL | 1.31 | 0.133 | 1.33 | 40 | 80 | **10** | 0.98 | 0.03 | 0.02 |
| Tier 2 UCL | 0.978 | 0.133 | 1.33 | 40 | 80 | **7** | 0.7 | 0.02 | 0.01 |
| **Nickel (Alternative Exposure Scenario; Median BAFs)** | | | | | | | | | |
| *Deer Mouse - Insectivore* | | | | | | | | | |
| Tier 1 UTL | 1.80 | 0.133 | 1.33 | 40 | 80 | **14** | 1 | 0.04 | 0.02 |
| Tier 1 UCL | 1.12 | 0.133 | 1.33 | 40 | 80 | **8** | 0.8 | 0.03 | 0.01 |
| Tier 2 UTL | 1.29 | 0.133 | 1.33 | 40 | 80 | **10** | 0.97 | 0.03 | 0.02 |
| Tier 2 UCL | 0.962 | 0.133 | 1.33 | 40 | 80 | **7** | 0.7 | 0.02 | 0.01 |

N/A = Not applicable.

**Bold = Hazard Quotients greater than 1.**

**Table A4.3.10**
**Terrestrial Plant Hazard Quotients for Silver in WBEU Surface Soils**

| Receptor/ EPC Statistic | Concentration (mg/kg) | TRV (mg/kg) | Hazard Quotients |
|---|---|---|---|
| | | Screening ESL | Screening ESL |
| *Terrestrial Plant* | | | |
| Tier 1 UTL | 2.6 | 2 | 1 |
| Tier 1 UCL | 3.51 | 2 | **2** |
| Tier 2 UTL | 1.95 | 2 | 0.98 |
| Tier 2 UCL | 1.85 | 2 | 0.9 |

**Bold = Hazard Quotient greater than 1.**

**Table A4.3.11**
**Terrestrial Plant Hazard Quotients for Thallium in WBEU Surface Soils**

| Receptor/ EPC Statistic | Concentration (mg/kg) | TRV (mg/kg) | Hazard Quotients |
|---|---|---|---|
| | | Screening ESL | Screening ESL |
| *Terrestrial Plant* | | | |
| Tier 1 UTL | 1.1 | 1 | 1 |
| Tier 1 UCL | 0.556 | 1 | 0.6 |
| Tier 2 UTL | 1.03 | 1 | 1 |
| Tier 2UCL | 0.527 | 1 | 0.5 |

**Table A4.3.12**
**Non-PMJM Intake Estimates for Tin in WBEU Surface Soils: Default Exposure Scenario**

| **Bioaccumulation Factors** | | | | | | |
|---|---|---|---|---|---|---|
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| 0.03 | 1 | 0.21 | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 31 | Tier 1 UTL | 0.93 | 31.00 | 6.51 | 0.068 | |
| 14 | Tier 1 UCL | 0.42 | 14.00 | 2.94 | 0.047 | |
| 35.8 | Tier 2 UTL | 1.07 | 35.80 | 7.52 | 0.068 | |
| 19.9 | Tier 2 UCL | 0.60 | 19.90 | 4.18 | 0.047 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$** (kg/kg BW day) | **$IR_{(water)}$** (kg/kg BW day) | **$IR_{(soil)}$** (kg/kg BW day) | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Mourning Dove - Herbivore | 0.23 | 0.12 | 0.021 | 1 | 0 | 0 |
| Mourning Dove - Insectivore | 0.23 | 0.12 | 0.021 | 0 | 1 | 0 |
| American Kestrel | 0.092 | 0.12 | 0.005 | 0 | 0.2 | 0.8 |
| Deer Mouse - Insectivore | 0.065 | 0.19 | 0.001 | 0 | 1 | 0 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Mourning Dove - Herbivore* | | | | | | |
| Tier 1 UTL | 0.214 | N/A | N/A | 0.663 | 0.00816 | 0.885 |
| Tier 1 UCL | 0.0966 | N/A | N/A | 0.299 | 0.00564 | 0.402 |
| Tier 2 UTL | 0.247 | N/A | N/A | 0.766 | 0.00816 | 1.02 |
| Tier 2 UCL | 0.137 | N/A | N/A | 0.426 | 0.00564 | 0.569 |
| *Mourning Dove - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 7.13 | N/A | 0.663 | 0.00816 | 7.80 |
| Tier 1 UCL | N/A | 3.22 | N/A | 0.299 | 0.00564 | 3.53 |
| Tier 2 UTL | N/A | 8.23 | N/A | 0.766 | 0.00816 | 9.01 |
| Tier 2 UCL | N/A | 4.58 | N/A | 0.426 | 0.00564 | 5.01 |
| *American Kestrel* | | | | | | |
| Tier 1 UTL | N/A | 0.570 | 0.479 | 0.143 | 0.00816 | 1.20 |
| Tier 1 UCL | N/A | 0.258 | 0.216 | 0.0644 | 0.00564 | 0.544 |
| Tier 2 UTL | N/A | 0.659 | 0.553 | 0.165 | 0.00816 | 1.38 |
| Tier 2 UCL | N/A | 0.366 | 0.308 | 0.0915 | 0.00564 | 0.771 |
| *Deer Mouse - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 2.02 | N/A | 0.0403 | 0.0129 | 2.07 |
| Tier 1 UCL | N/A | 0.910 | N/A | 0.0182 | 0.00893 | 0.937 |
| Tier 2 UTL | N/A | 2.33 | N/A | 0.0465 | 0.0129 | 2.39 |
| Tier 2 UCL | N/A | 1.29 | N/A | 0.0259 | 0.00893 | 1.33 |

N/A = Not applicable.

**Table A4.3.13**
**Non-PMJM Hazard Quotients for Tin in WBEU Surface Soils**

| Receptor/ EPC Statistic | Total Intake (mg/kg BW day) | TRV (mg/kg BW day) | | Hazard Quotients | |
|---|---|---|---|---|---|
| | | NOAEL | LOAEL | NOAEL | LOAEL |
| **Tin (Default Exposure)** | | | | | |
| *Mourning Dove - Herbivore* | | | | | |
| Tier 1 UTL | 0.885 | 0.730 | 18.3 | 1 | 0.05 |
| Tier 1 UCL | 0.402 | 0.730 | 18.3 | 0.6 | 0.02 |
| Tier 2 UTL | 1.02 | 0.730 | 18.3 | 1 | 0.06 |
| Tier 2 UCL | 0.569 | 0.730 | 18.3 | 0.8 | 0.03 |
| *Mourning Dove - Insectivore* | | | | | |
| Tier 1 UTL | 7.80 | 0.730 | 18.3 | **11** | 0.4 |
| Tier 1 UCL | 3.53 | 0.730 | 18.3 | **5** | 0.2 |
| Tier 2 UTL | 9.01 | 0.730 | 18.3 | **12** | 0.5 |
| Tier 2 UCL | 5.01 | 0.730 | 18.3 | **7** | 0.3 |
| *American Kestrel* | | | | | |
| Tier 1 UTL | 1.20 | 0.730 | 18.3 | **2** | 0.07 |
| Tier 1 UCL | 0.544 | 0.730 | 18.3 | 0.7 | 0.03 |
| Tier 2 UTL | 1.38 | 0.730 | 18.3 | **2** | 0.08 |
| Tier 2 UCL | 0.771 | 0.730 | 18.3 | 1 | 0.04 |
| *Deer Mouse - Insectivore* | | | | | |
| Tier 1 UTL | 2.07 | 0.250 | 15 | **8** | 0.1 |
| Tier 1UCL | 0.937 | 0.250 | 15 | **4** | 0.1 |
| Tier 2 UTL | 2.39 | 0.250 | 15 | **10** | 0.2 |
| Tier 2 UCL | 1.33 | 0.250 | 15 | **5** | 0.1 |

**Bold = Hazard Quotients greater than 1.**

**Table A4.3.14**
**Non-PMJM Intake Estimates for Bis(2-ethylhexyl)phthalate in WBEU Surface Soils; Default Exposure Scenario**

| **Bioaccumulation Factors** | | | | | | |
|---|---|---|---|---|---|---|
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| 0.15 | 34.9 | 28.81 | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 0.51 | Tier 1 UTL | 0.08 | 17.8 | 14.69 | 0 | |
| 0.224 | Tier 1 UCL | 0.03 | 7.8 | 6.45 | 0 | |
| 0.29 | Tier 2 UTL[a] | 0.04 | 10.1 | 8.35 | 0 | |
| 0.21 | Tier 2 UCL | 0.03 | 7.3 | 6.05 | 0 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$** (kg/kg BW day) | **$IR_{(water)}$** (kg/kg BW day) | **$IR_{(soil)}$** (kg/kg BW day) | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Mourning Dove - Insectivore | 0.23 | 0.12 | 0.021 | 0 | 1 | 0 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Mourning Dove - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 4.09 | N/A | 0.01091 | 0 | 4.10 |
| Tier 1 UCL | N/A | 1.80 | N/A | 0.00479 | 0 | 1.80 |
| Tier 2 UTL[a] | N/A | 2.33 | N/A | 0.00620 | 0 | 2.33 |
| Tier 2 UCL | N/A | 1.69 | N/A | 0.00449 | 0 | 1.69 |

[b]Tier 2 soil UTL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration.
N/A = Not applicable.

**Table A4.3.15**

**Non-PMJM Hazard Quotients for Bis(2-ethylhexyl)phthalate in WBEU Surface Soils**

| Receptor/ EPC Statistic | | TRV (mg/kg BW day) | | Hazard Quotients | |
|---|---|---|---|---|---|
| | **Total Intake** | **NOAEL** | **LOAEL** | **NOAEL** | **LOAEL** |
| **Bis(2-ethylhexyl)phthalate (Default Exposure)** | | | | | |
| *Mourning Dove - Insectivore* | | | | | |
| Tier 1 UTL | 4.10 | 1.1 | 214 | **4** | 0.02 |
| Tier 1 UCL | 1.80 | 1.1 | 214 | **2** | 0.01 |
| Tier 2 UTL[a] | 2.33 | 1.1 | 214 | **2** | 0.01 |
| Tier 2 UCL | 1.69 | 1.1 | 214 | **2** | 0.01 |

[b]Tier 2 soil UTL was greater than the maximum grid average, or could not be calculated due to low numbers of samples, so the maximum grid average was used as a proxy exposure point concentration to calculate intake.

**Bold = Hazard quotients greater than 1.**

**Table A4.3.16**
**Non-PMJM Intake Estimates for Endrin in WBEU Surface Soils; Default Exposure Scenario**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Bioaccumulation Factors** | | | | | | |
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| 0.32 | 31.1 | 28.49 | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 0.0105 | Tier 1 UTL | 0.00 | 0.3 | 0.30 | 0 | |
| 0.0093 | Tier 1 UCL | 0.00 | 0.3 | 0.26 | 0 | |
| 0.0158 | Tier 2 UTL[a] | 0.01 | 0.5 | 0.45 | 0 | |
| 0.0101 | Tier 2 UCL | 0.00 | 0.3 | 0.29 | 0 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$** (kg/kg BW day) | **$IR_{(water)}$** (kg/kg BW day) | **$IR_{(soil)}$** (kg/kg BW day) | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Mourning Dove - Insectivore | 0.23 | 0.12 | 0.021 | 0 | 1 | 0 |
| American Kestrel | 0.092 | 0.12 | 0.005 | 0 | 0.2 | 0.8 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Mourning Dove - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 0.0751 | N/A | 2.25E-04 | 0 | 0.0753 |
| Tier 1 UCL | N/A | 0.0665 | N/A | 1.99E-04 | 0 | 0.0667 |
| Tier 2 UTL[a] | N/A | 0.113 | N/A | 3.38E-04 | 0 | 0.113 |
| Tier 2 UCL | N/A | 0.0722 | N/A | 2.16E-04 | 0 | 0.0725 |
| *American Kestrel* | | | | | | |
| Tier 1 UTL | N/A | 0.00601 | 0.0220 | 4.83E-05 | 0 | 0.0281 |
| Tier 1 UCL | N/A | 0.00532 | 0.0195 | 4.28E-05 | 0 | 0.0249 |
| Tier 2 UTL[a] | N/A | 0.00904 | 0.0331 | 7.27E-05 | 0 | 0.0422 |
| Tier 2 UCL | N/A | 0.00578 | 0.0212 | 4.65E-05 | 0 | 0.0270 |

[a]Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples so the MDC was used as a proxy value for calculating intake.
N/A = Not applicable.

**Table A4.3.17**
**Non-PMJM Hazard Quotients for Endrin in WBEU Surface Soils**

| Receptor/ EPC Statistic | | TRV (mg/kg BW day) | | Hazard Quotients | |
|---|---|---|---|---|---|
| | Total Intake | NOAEL | LOAEL | NOAEL | LOAEL |
| **Endrin (Default Exposure)** | | | | | |
| *Mourning Dove - Insectivore* | | | | | |
| Tier 1 UTL | 0.0753 | 0.0100 | 0.100 | **8** | 0.8 |
| Tier 1 UCL | 0.0667 | 0.0100 | 0.100 | **7** | 0.7 |
| Tier 2 UTL[a] | 0.113 | 0.0100 | 0.100 | **11** | 1 |
| Tier 2 UCL | 0.0725 | 0.0100 | 0.100 | **7** | 0.7 |
| *American Kestrel* | | | | | |
| Tier 1 UTL | 0.0281 | 0.0100 | 0.100 | **3** | 0.3 |
| Tier 1 UCL | 0.0249 | 0.0100 | 0.100 | **2** | 0.2 |
| Tier 2 UTL[a] | 0.0422 | 0.0100 | 0.100 | **4** | 0.4 |
| Tier 2 UCL | 0.0270 | 0.0100 | 0.100 | **3** | 0.3 |

[a]Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value for calculating intake.
N/A = Not applicable.
**Bold = Hazard quotients greater than 1.**

**Table A4.3.18**
**Non-PMJM Intake Estimates for Total PCBs in WBEU Surface Soils; Default Exposure Scenario**

| **Bioaccumulation Factors** | | | | | | |
|---|---|---|---|---|---|---|
| Soil to Plant | Soil to Invertebrate | Soil to Small Mammal | | | | |
| 0.25 | lnCe = 1.41 + 1.361(lnCs) | 28.79 | | | | |
| **Media Concentrations (mg/kg)** | | | | | | |
| **Soil Concentration** | **Statistic** | **Plant** | **Earthworm** | **Small Mammal** | **Surface Water (mg/L)** | |
| 0.38 | Tier 1 UTL | 0.10 | 1.1 | 10.94 | 0 | |
| 0.449 | Tier 1 UCL | 0.11 | 1.4 | 12.93 | 0 | |
| 0.415 | Tier 2 UTL | 0.10 | 1.2 | 11.95 | 0 | |
| 0.306 | Tier 2 UCL | 0.08 | 0.8 | 8.81 | 0 | |
| **Intake Parameters** | | | | | | |
| | **$IR_{(food)}$ (kg/kg BW day)** | **$IR_{(water)}$ (kg/kg BW day)** | **$IR_{(soil)}$ (kg/kg BW day)** | **$P_{plant}$** | **$P_{invert}$** | **$P_{mammal}$** |
| Mourning Dove - Insectivore | 0.23 | 0.12 | 0.021 | 0 | 1 | 0 |
| American Kestrel | 0.092 | 0.12 | 0.005 | 0 | 0.2 | 0.8 |
| **Intake Estimates (mg/kg BW day)** | | | | | | |
| | **Plant Tissue** | **Invertebrate Tissue** | **Mammal Tissue** | **Soil** | **Surface Water** | **Total** |
| *Mourning Dove - Insectivore* | | | | | | |
| Tier 1 UTL | N/A | 0.252 | N/A | 0.00813 | 0 | 0.261 |
| Tier 1 UCL | N/A | 0.317 | N/A | 0.00960 | 0 | 0.326 |
| Tier 2 UTL | N/A | 0.285 | N/A | 0.00888 | 0 | 0.293 |
| Tier 2 UCL | N/A | 0.188 | N/A | 0.00655 | 0 | 0.195 |

N/A = Not applicable.

**Table A4.3.19**
**Non-PMJM Hazard Quotients for Total PCBs in WBEU Surface Soils**

| Receptor/ EPC Statistic | Total Intake (mg/kg BW day) | TRV (mg/kg BW day) | | Hazard Quotients | |
|---|---|---|---|---|---|
| | | NOAEL | LOAEL | NOAEL | LOAEL |
| **PCB (Total) (Default Exposure)** | | | | | |
| *Mourning Dove - Insectivore* | | | | | |
| Tier 1 UTL | 0.261 | 0.0900 | 1.27 | **3** | 0.2 |
| Tier 1 UCL | 0.326 | 0.0900 | 1.27 | **4** | 0.3 |
| Tier 2 UTL | 0.293 | 0.0900 | 1.27 | **3** | 0.2 |
| Tier 2 UCL | 0.195 | 0.0900 | 1.27 | **2** | 0.2 |

N/A = Not applicable.

**Bold = Hazard quotients greater than 1.**

# COMPREHENSIVE RISK ASSESSMENT

## WIND BLOWN AREA EXPOSURE UNIT

## VOLUME 9: ATTACHMENT 5

## Chemical-Specific Uncertainty Analysis

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BAF | bioaccumulation factor |
| CMS | Corrective Measures Study |
| CRA | Comprehensive Risk Assessment |
| DOE | U.S. Department of Energy |
| ECOI | ecological contaminant of interest |
| ECOPC | ecological contaminant of potential concern |
| EcoSSL | Ecological Soil Screening Level |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| ESL | ecological screening level |
| HQ | hazard quotient |
| LOAEL | lowest observed adverse effect level |
| LOEC | lowest observed effect concentration |
| mg/kg | milligrams per kilogram |
| mg/kg BW/day | milligrams per kilogram per receptor body weight per day |
| NOAEL | No observed adverse effect level |
| NOEC | No observed effect concentration |
| PCB | polychlorinated biphenyl |
| PMJM | Preble’s meadow jumping mouse |
| RCRA | Resource Conservation and Recovery Act |
| RFETS | Rocky Flats Environmental Technology Site |
| RI/FS | Remedial Investigation/Feasibility Study |
| TRV | toxicity reference value |

| | |
|---|---|
| UCL | upper confidence limit |
| UTL | upper tolerance limit |

# 1.0 INTRODUCTION

One potential limitation of the hazard quotient (HQ) approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on two potential sources of uncertainty, described below.

- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue}$ = BAF * $C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. In order to estimate more typical tissue concentrations, where necessary, an alternative exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the U.S. Environmental Protection Agency (EPA) ecological soil screening level (EcoSSL) guidance (EPA 2005).
- **Toxicity Reference Values (TRVs).** The Comprehensive Risk Assessment (CRA) Methodology (U.S. Department of Energy [DOE] 2005), used an established hierarchy to identify the most appropriate default TRVs for use in the ecological contaminant of potential concern (ECOPC) selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis in the following subsections. When an alternative TRV is identified, the chemical-specific subsections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs are discussed for each ECOPC in the following subsections.

## 1.1 Chromium

### *Plant and Invertebrate Toxicity*

For terrestrial plants, the summary of chromium toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants and the basis for the ecological screening level (ESL) is not discussed in the document. The document simply notes that confidence in the values is low due to the small number of studies on which it was based. Efroymson et al. (1997a) also provides plant toxicity values from Turner and Rust (1971) that are based on growth effects on plants grown in loamy soils. No effects to plant growth were noted at 10 milligrams per kilogram (mg/kg) while shoot weight was reduced by 30 percent at chromium concentrations equal to 30 mg/kg. Uncertainty is high using the alternative values but reduced from the unspecified and unsupported 1 mg/kg value used as the default ESL.

For terrestrial invertebrates, the ESL is based on survival effects to earthworms exposed to hexavalent chromium (chromium VI). Severe effects on survival were noted at 2 mg/kg chromium VI. The 0.4 mg/kg ESL was calculated by Efroymson et al. (1997b) by dividing be a safety factor of 5. There is some uncertainty in the chromium VI TRV because trivalent chromium (chromium III) is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002). This introduces uncertainty into the TRV selection process as chromium VI is regarded as the more toxic form of chromium. Efroymson et al. (1997b) also provide data for a lowest observed effect concentration (LOEC) where growth to earthworms was reduced by 30 percent at 32.6 mg/kg of chromium III. The alternative chromium III LOEC provides a useful alternative estimate of toxicity based on a more applicable estimate of chromium III toxicity.

***Bioaccumulation Factors***

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Chromium has two types of bioaccumulation factors used in the intake calculations. For the soil-to-small mammal BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of chromium to an unknown degree.

The soil-to-invertebrate and soil-to-plant BAFs used to estimate invertebrate tissue concentrations are both based on screening-level upper-bound (90th percentile) BAFs presented in Sample et al. (1998a) and ORNL (1998). These values provide conservative estimates of uptake from soils to invertebrate and plant tissues. This conservative estimate may serve to overestimate chromium concentrations in tissues. For this reason, the median BAFs presented in the same documents were used as alternative BAFs to estimate invertebrate and plant tissue concentrations as recommended in USEPA Eco-SSL guidance (EPA 2005). It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

***Toxicity Reference Values***

For birds, the NOAEL and LOAEL TRVs are based on mortality effects in black ducks from chromium III and were obtained from Sample et al. (1996). The NOAEL TRV (1.0 mg/kg BW/day) represents a dose at which no effects on the survival of ducks were noted. The LOAEL TRV (5.0 mg/kg BW/day) represents a dose at which a decrease in survivability was noted in the same study. Because the effects endpoint is based on mortality, no threshold TRV was calculated in the CRA Methodology. However, the threshold for chromium III toxicity lies somewhere between the NOAEL and LOAEL, but the true threshold dose is not known. No toxicity data were available for chromium VI, so avian TRVs for chromium VI could not be derived. However, chromium III is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002). Because the avian NOAEL and LOAEL TRVs are based on appropriate endpoints and the chemical form most likely to be present in soil, uncertainty in the avian TRVs is considered low. No alternative avian TRVs were identified for chromium III.

For mammals, both a NOAEL and LOAEL TRVs were available for chromium VI, but only a NOAEL TRV was available for chromium III. All of the mammalian TRVs were obtained from Sample et al. (1996) and relate to reproduction and mortality endpoints. For chromium III, The NOAEL TRV (2,737 mg/kg BW/day) represents a dose at which no effects on reproduction or longevity were noted. For chromium VI, the NOAEL TRV (3.28 mg/kg BW/day) represents a dose at which no body weight or food consumption effects were noted in rats. The LOAEL TRV (13.14 mg/kg BW/day) for chromium VI, which was derived from a different study than the NOAEL TRV, represents the dose at which mortality effects were noted in rats. Both the chromium III and chromium VI TRVs were used in the default analysis. However, as noted above, chromium III is likely to be the chemical form present in soils at RFETS. Since both chromium III and chromium VI TRVs were based on acceptable effects endpoints, no alternative TRVs were identified.

Since the completion of the TRV derivation process in the CRA Methodology, EPA has derived Eco-SSLs for both birds (chromium III only) and mammals (chromium III and chromium VI) (EPA 2005). While the Eco-SSL TRVs were not utilized in the default analysis, a comparison of Eco-SSL TRVs to those selected by Sample et al. (1996) which were used in the default analysis provides information on the applicability of and underlying uncertainties in the selected TRVs. For birds, the dose-based TRV derived for chromium III (2.66 mg/kg BW/day) was based on the geomean of all growth and reproduction NOAELs. As seen, this TRV is similar to the chromium III TRVs identified by Sample et al. (1996) utilized in the default analysis. This supports the conclusion that uncertainty in the avian TRVs for chromium III is low.

For mammals, the Eco-SSL dose-based TRV derived for chromium III (2.4 mg/kg BW/day) was based on the geomean of all growth and reproduction NOAELs. As seen, the Eco-SSL TRV is more than 1000 times lower than the NOAEL TRV selected by Sample et al. (1996). Inspection of the toxicity dataset for chromium III provided in EPA (2005) shows that there are several unbounded LOAELs below the NOAEL TRV selected by Sample et al. (1996). Therefore, the uncertainty associated with the mammalian chromium III NOAEL TRV utilized in the default analysis is high. The mammalian dose-based TRV derived for chromium VI (5.66 mg/kg BW/day) was based on the highest bounded NOAEL below the lowest bounded LOAEL for growth, reproduction, or survival, and is similar to the chromium VI TRVs identified by Sample et al. (1996) utilized in the default analysis. However, as noted above, chromium III is likely to be the chemical form present in soils at RFETS, so HQs based on a TRV for chromium VI are also uncertain.

***Background Risks***

Chromium was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to terrestrial plants, terrestrial invertebrates, mourning dove (herbivore and insectivore), American kestrel and deer mouse (insectivore) were calculated using both the upper confidence limit (UCL) and upper tolerance limit (UTL) of background soils. No observed adverse effect level (NOAEL) HQs greater than 1 were calculated for terrestrial plants, terrestrial invertebrates, and mourning dove (insectivore) with both the UCL and UTL exposure point concentrations (EPCs). NOAEL HQs for terrestrial plants equaled 17 using the UTL while those calculated for terrestrial invertebrates equaled 42. Both NOAEL and LOAEL HQs greater than 1 were calculated for the mourning dove (insectivore). The LOAEL HQ equaled 3 using the UTL EPC. No LOAEL TRVs were available for terrestrial plants or invertebrates.

## 1.2 Manganese

***Bioaccumulation Factors***

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Manganese has two types of bioaccumulation factors used in the intake calculations. For the soil-to-invertebrate BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate invertebrate tissue concentrations of manganese to an unknown degree.

The soil-to-plant and soil-to-small mammal BAFs used to estimate tissue concentrations are based on screening-level, upper-bound (90th percentile) BAFs presented in ORNL (1998) and Sample et al. (1998b). These values provide conservative estimates of uptake from soils to tissues. This conservative estimate may serve to overestimate manganese concentrations in plant and small mammal tissues. For this reason, the median BAFs presented in the same document were used as alternative BAFs to estimate tissue concentrations. It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of plant and small mammal tissue concentrations, but the likelihood of overestimation of risks is reduced. In addition, the conservative nature of the upper-bound soil-to-plant BAF directly affects the conservatisms in the soil-to-small mammal BAF that uses both the soil-to-plant and soil-to-invertebrate BAFs in its calculation. It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

### *Toxicity Reference Values*

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which a decrease in testical weight in mice was noted. The NOAEL TRV was taken from the same study and represents an intake rate at which no effects on testicular weight were noted. No threshold TRV was identified in the CRA Methodology, so it is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV. In addition, no relationship appears to have been identified between decreased testicular weight to reductions in reproductive success. This introduces some uncertainty into the risk assessment. However, because the endpoint for the LOAEL TRV is based on potential reproductive effects, the uncertainty is likely to be limited. Risks predicted by the LOAEL TRV may be overestimated, but the degree of uncertainty is low.

### *Background Risks*

Manganese was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to all receptors including the deer mouse (herbivore) were calculated using both the UCL and UTL of background soils. NOAEL HQs less than 1 were calculated for the deer mouse (herbivore). No HQs greater than 1 were calculated for any receptor using LOAEL TRVs.

## 1.3 Nickel

### *Bioaccumulation Factors*

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Nickel has two types of bioaccumulation factors used in the intake calculations. For the soil-to-plant and soil-to-small mammal BAFs, regression equations were used to estimate tissue concentrations. Confidence placed in these values is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of nickel to an unknown degree.

The soil-to-invertebrate BAF used to estimate invertebrate tissue concentrations is based on a screening-level upper bound (90th percentile) BAF presented in Sample et al. (1998a). This value provides a conservative estimate of uptake from soils to invertebrate tissues. This conservative estimate may serve to overestimate nickel concentrations in invertebrate tissues. For this reason, the median BAF presented in the same document (Sample et al. 1998b) can be used as an alternative BAF to estimate invertebrate tissue concentrations.

It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

***Toxicity Reference Values***

Uncertainty is also present in the TRVs used in the default HQ calculations for nickel. The NOAEL-based ESL calculated for the deer mouse (insectivore) was equal to 0.431 mg/kg, a concentration less than all site-specific background samples (minimum background concentration = 3.8 mg/kg). The NOAEL TRV used to calculate the ESL was estimated from the LOAEL TRV in the CRA Methodology by dividing by a factor of 10. The LOAEL TRV for mammals (1.33 mg/kg receptor body weight [BW]/day) is based on pup mortality in rats. Given that the LOAEL TRV is 10 times the NOAEL TRV, a back-calculated soil concentration using the LOAEL TRV equals 3.8 mg/kg. This concentration is equal to the minimum detected concentration of nickel in background soils and would be exceeded by 19 of the 20 site-specific background soil concentrations.

For avian receptors, there is also uncertainty in the quality of the TRVs selected in the CRA Methodology to predict population-level effects to birds at RFETS. The TRVs selected by PRC (1994) relate to the prediction of edema and swelling in leg and foot joints in mallard ducks. The CRA Methodology noted that the nature of the effect predicted by the LOAEL TRV is not likely to cause significant effects on growth, reproduction, or survival in birds and, subsequently, calculated a threshold TRV. The threshold TRV represents an estimate of the point between the NOAEL and LOAEL TRVs where effects related to the LOAEL TRV may begin to occur. This point is uncertain, and it is impossible to accurately estimate where the threshold for effects lies. Therefore, the calculation of the threshold TRV may overestimate or underestimate the calculated risks by a degree less than half of the difference between the NOAEL and LOAEL TRVs. In addition, the ability of the LOAEL TRV endpoint to predict effects to populations of avian receptors at RFETS under the assessment endpoints used in this CRA is also uncertain. The effect that swelling of leg and toe joints in birds has on population-level endpoints is unclear, and risk estimations are likely to be conservative and over-predict risks related to the assessment endpoints.

Given the uncertainties related to the TRVs for both mammals and birds, a further review of TRVs was conducted to provide additional toxicologically-based information for use in the risk characterization. The CRA Methodology prescribed a hierarchy of TRV sources from which TRVs could be identified and used without modification. TRVs were selected first from EPA Eco-SSL guidance (EPA 2003) from which no nickel TRVs were available. The second tier TRV source was PRC (1994), from which the TRVs were obtained. Due to the uncertain nature of predicting potential risk at even the lowest end of the range of background concentrations in an uncontaminated background area, additional TRVs were identified from the third tier TRV source (Sample et al. 1996).

Sample et al. (1996) presents TRVs for birds and mammals that provide useful comparison points to the default TRVs identified in the CRA Methodology.

For mammals, the alternative TRVs were derived from a multi-generational study of rat reproduction and changes due to nickel contamination in food items. At a dose level equal to 80 mg/kg BW/day (LOAEL), significant decreases were noted in offspring weight in rats. No effects were noted at 40 mg/kg BW/day (NOAEL). The effect-endpoint is questionable in terms of predicting population level effects based on the assessment endpoint, but was identified as an acceptable endpoint in the CRA Methodology. These values can be used in conjunction with the alternative BAFs discussed above to provide risk managers with another valuable line of evidence to be used in making risk management decisions.

For birds, the alternative TRVs were derived from a chronic exposure study on mallard ducklings exposed to nickel in food items. No growth, reproductive or mortality-based effects were noted at the 77.4 mg/kg BW/day dose level (NOAEL) but significant decreased in growth rate and increased in mortality were noted at the 107 mg/kg BW/day dose level (LOAEL). As with the mammalian alternative TRVs, these values can be used in conjunction with the alternative BAFs discussed above to provide risk managers with another valuable line of evidence to be used in making risk management decisions.

The use of these alternative risk calculations serves to provide an estimate of risk using a reasonable, yet reduced, level of conservatism for all receptors and a reduction of uncertainty (to an unknown extent) for the deer mouse (insectivore) receptor.

***Background Risks***

Nickel was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the deer mouse (insectivore and herbivore), coyote (generalist and insectivore), and mourning dove (insectivore) were calculated using both the UCL and UTL of background soils and default NOAEL, threshold (mourning dove only), and LOAEL TRVs.

NOAEL HQs greater or equal to 1 for all receptors were calculated using both the UCL and UTL background surface soil concentrations. LOAEL HQs were less than 1 for the deer mouse (herbivore), mourning dove (insectivore), and both coyote receptors but greater than 1 for the deer mouse (insectivore) (HQ = 3). Site-specific background concentrations of nickel do not appear to be elevated as the maximum detected concentration in background surface samples equaled 14.0 mg/kg which is lower than the mean concentration of nickel in Colorado and bordering states (18.8 mg/kg) as discussed in Attachment 3.

## 1.4 Silver

### *Plant Toxicity*

The summary of silver toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants, and the ESL value is based on unspecified toxic effects. The only additional TRV information available in the literature was an ESL soil screening benchmark from EPA Region 5. Low confidence is also placed in this benchmark because no effects are specified and the benchmark is based on the lowest receptor-specific ESL for either plants, invertebrates, or mammals. The uncertainty associated with the lack of toxicity data for silver is high. It is unclear whether risks are overestimated or underestimated by using the default or the benchmark from EPA Region 5. However, overestimation is the more likely scenario because both are termed screening levels and represent unclear effects. Because of the uncertainties associated with the Region 5 benchmark, no refined analysis is presented in the risk characterization.

### *Background Risk Calculations*

Silver was not detected in background surface soils. Therefore, background risks were not calculated for silver in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

## 1.5 Thallium

### *Plant Toxicity*

The summary of thallium toxicity in Efroymson et al. (1997a) places low confidence in the value because the ESL value is based on unspecified toxic effects. The only additional TRV that could be located was the same as the default value. The uncertainty associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default toxicity value but overestimation is the more likely scenario because the ESL is termed a screening level and represent unclear effects.

### *Background Risk Calculations*

Thallium was not detected in background surface soils. Therefore, background risks were not calculated for thallium in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

## 1.6 Tin

### *Bioaccumulation Factors*

The primary source of uncertainty in the risk estimation for tin is in the estimation of tissue concentrations. No high-quality regression models or BAF data were available for any of the three soil-to-tissue pathways. As a result, plant tissue concentrations are estimated using a biotransfer factor from soil-to-plant tissue from Baes et al. (1984). The values presented in Baes et al. (1994) were the lowest tier for data quality in the CRA Methodology and represent the most uncertain BAF available. It is unclear whether the

Baes et al. (1984) BAFs overestimate or underestimate uptake into plant tissues, and the magnitude of uncertainty is also unknown but could be high.

No data were available to estimate invertebrate concentrations from soil. As a result, a default value of 1 was used. This value assumes that the concentration in invertebrate tissues is equal to the surface soil concentration. There is a large degree of uncertainty in this assumption. Because tin is not expected to bioaccumulate in the food chain, invertebrate tissue concentrations are likely to be overestimated to an unknown degree using this BAF. The lack of quality soil-to-plant and soil-to-invertebrate BAFs directly affects the quality of the soil-to-small mammal BAF that uses the previous two values in its calculation. Compounding the uncertainty for this BAF is a food-to-tissue BAF, again from Baes et al. (1984). It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

### *Toxicity Reference Values*

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994). The selected NOAEL TRV is protective of systemic effects in mice. These effects are not associated with the assessment endpoints for mammalian receptors at RFETS and, therefore, are overly conservative for use in the CRA. However, the LOAEL TRV selected by PRC (1994) is from a proper endpoint for use in the CRA and is described by PRC (1994) as predictive of a mid-range of effects less than mortality. Therefore, while the uncertainty related to the NOAEL TRV for mammals is high, the uncertainty for the LOAEL TRV is considerably lower. For this reason, no alternative TRVs are recommended in the uncertainty analysis.

For avian receptors, the TRVs selected for use in the CRA were also obtained from PRC (1994) and represent a paired NOAEL and LOAEL from a study on Japanese quail reproduction. No effects on reproduction were noted at the NOAEL, while reduced reproduction was noted at the LOAEL intake rate. Because the endpoints represented by the TRVs are appropriate for use in the CRA, the uncertainty in the avian TRVs for tin is considered to be low.

All of the TRVs used for tin were based on toxicity to tributyl tin. Tributyl tin compounds are commonly regarded as the most toxic forms of tin while inorganic tins are likely to be among the least toxic forms. In terrestrial environments, organic forms of tin, such as tributyl tin, on which the TRVs are based are not generally found in elevated concentrations unless a source of them is nearby. No known source of organic tin is present at RFETs. It is likely that much of the tin detected in soil samples is either inorganic tin or in compounds less toxic than tributytin. The use of tributyltin TRVs likely overestimates risks from tin to an unknown degree.

## *Background Risk Calculations*

Tin was not detected in background surface soils, therefore, background risks were not calculated for tin in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

## 1.7 Bis(2-Ethylhexyl)Phthalate

### *Bioaccumulation Factors*

Invertebrate tissue concentrations for bis(2-ethylhexyl)phthalate were estimated using uptake models based on the log $K_{ow}$ of bis(2-ehtylhexyl)phthalate. As cited in the CRA Methodology, if organic ecological contaminants of interest (ECOIs) with no empirically calculated BAFs available in the first two sources, log $K_{ow}$ equations are used (as presented and modified in the EPA Eco-SSL [EPA 2003]). Log $K_{ow}$-based values are more uncertain than empirically based BAFs and are likely to overestimate tissue concentrations to an unknown degree.

This uncertainty is compounded in the soil-to-small mammal BAF, which uses both the soil-to-invertebrate and the soil-to-plant BAFs (also log $K_{ow}$-based) to estimate the diet of the small mammal. A second model (based on the log $K_{ow}$) is the used to estimate the amount of ECOI transferred from first trophic-level food items to the second trophic-level prey tissues that are ingested by the predator. This compounded uncertainty may overestimate the concentrations of bis(2-ethylhexyl)phthalate by a larger degree than noted for the soil-to-invertebrate pathway.

### *Toxicity Reference Values*

Appendix B of the CRA Methodology (DOE 2005) presents only a NOAEL TRV for avian effects from bis(2-ethylhexyl)phthalate. No reproductive effects were noted in ring doves at a dose of 1.1 mg/kg BW/day. Because no effects were noted at the highest dose level in the study presented in the CRA Methodology, EPA's Ecotox database was searched for an alternative study. The following study was identified as applicable for use in the risk characterization.

European starlings were fed a concentration of 0, 25, and 250-mg/kg bis(2-ethylhexyl)phthalate via diet daily (O'Shea and Stafford 1980). Significant increases in body weight were noted at the 25 mg/kg level, which was identified as the LOAEL. The water content of the food was assumed to be 5 percent.

The effect of increased body weight on the health of bird populations is questionable. Bis(2-ethylhexyl)phthalate commonly causes an increase in liver weight in mammals, thus, it can be assumed that the same may be true in birds. Therefore, the resulting TRV can be used as the LOAEL for the risk characterization assuming that any predicted increase in body weight may be attributable to increases in organ weight. It is unknown what effect the increase of organ weight in birds may have on the assessment endpoints, however, LOAEL-based HQs serve to provide risk managers with an additional line of evidence with which to make risk management decisions. Potential adverse effects predicted for bird populations from exposure to bis(2-ethylhexyl)phthalate are uncertain and should be reviewed in terms of the quality of toxicological information available.

No food ingestion rates for the animals used in the study were provided in the Ecotox database, so they were estimated. The ingestion rate for the American robin (EPA 1993) was used as a surrogate (food ingestion rate = 1.52 g/g BW/day). Converting the 25-mg/kg concentration to a dose resulted in a LOAEL TRV equal to 31.6 mg/kg BW day.

Dose = Cdiet · CF · IRfood = 25 · (1 - 0.05) · 1.52 = 36.1 mg/kg BW/d

Where:

Dose = exposure dose (mg/kg BW/d)
Cdiet = exposure concentration in diet (mg/kg food dry weight)
CF = dry weight to wet weight conversion factor [equal to 1- percent moisture]
IRfood = food ingestion rate (kg food wet weight/kg BW/d)

Given the questionable endpoint used in the LOAEL study, risks calculated using the LOAEL are likely to be overestimated to an unknown degree. However, the results of the LOAEL HQ calculations should be viewed in terms of the NOAEL HQs to provide an additional line of evidence regarding the lack of toxicity to bird species from bis(2-ethylhexyl)phthalate. The overall uncertainty associated with the TRVs used to assess risk to avian receptors from bis(2-ethylhexyl)phthalate is high.

### *Background Risk Calculations*

Bis(2-ethylhexyl)phthalate was not analyzed for in background surface soils. Therefore, background risks were not calculated for bis(2-ethylhexyl)phthalate in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

## 1.8 Endrin

#### *Bioaccumulation Factors*

All bioaccumulation factors used for endrin were log $K_{ow}$-based BAFs. As cited in the CRA Methodology, if organic ECOIs with no empirically calculated BAFs available in the first two sources, log $K_{ow}$ equations are used (as presented and modified in the EPA Eco-SSL [EPA 2003a]). These values are more uncertain than empirically based BAFs and are likely to overestimate tissue concentrations to an unknown degree.

#### *Toxicity Reference Values*

The TRV used was obtained from Sample et al. (1996) from a study of reproductive effects in screech owls. Egg production and hatching success were reduced at the LOAEL intake rate. No NOAEL TRV was available, so the NOAEL TRV was estimated from the LOAEL TRV by dividing by a factor of 10. The estimation of the NOAEL TRV from the LOAEL TRV introduces uncertainty into the risk characterization process. It is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV; therefore, it is unclear at which intake-rate the true NOAEL lies. However, this source of uncertainty is limited because LOAEL TRV is of sufficient quality to assess risks and the LOAEL TRV endpoint may be predictive of population risks. Risks predicted by the LOAEL TRV may be overestimated or underestimated, but the degree of uncertainty is low.

### *Background Risk Calculations*

Endrin was not analyzed for in background surface soils. Therefore, background risks were not calculated for endrin in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

## 1.9 Polychlorinated Biphenyls (Total)

### *Bioaccumulation Factors*

For the soil-to-invertebrate BAF, a regression equation was used to estimate invertebrate tissue concentrations. Confidence placed in this value is high. Uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. However, in cases without available measurements of tissue concentrations, regression-based models are the best available predictor of tissue concentrations. The regression-based BAF may overestimate or underestimate tissue concentrations of total polychlorinated biphenyls (PCBs) to an unknown degree.

Plant tissue concentrations for total PCBs were estimated using uptake models based on its log $K_{ow}$ (Aroclor 1254 used as a surrogate) . As cited in the CRA Methodology, if organic ECOIs with no empirically calculated BAFs available in the first two sources, log $K_{ow}$ equations are used (as presented and modified in EPA EcoSSL guidance [EPA 2003a]). Log $K_{ow}$-based values are more uncertain than empirically based BAFs and are likely to overestimate tissue concentrations to an unknown degree.

This uncertainty is compounded in the soil-to-small mammal BAF, which uses both the soil-to-invertebrate regression model and the soil-to-plant BAF to estimate the diet of the small mammal. A second model (based on the log $K_{ow}$) is used to estimate the amount of ECOI transferred from first trophic-level food items to the second trophic-level prey tissues that are ingested by the predator. This compounded uncertainty may overestimate the concentrations of total PCBs by a larger degree than noted for the soil-to-invertebrate pathway.

### *Toxicity Reference Values*

For avian receptors, total PCB TRVs were obtained from the database of TRVs from PRC (1994). The LOAEL TRV was derived from a study of reproductive effects in chickens. At the LOAEL intake rate, a significant decrease in egg hatchability was noted. The NOAEL TRV is set at an intake rate that showed potential effects on egg hatchability in chickens and then reduced by one-tenth to convert the concentration to a NOAEL. Because the NOAEL and LOAEL TRVs came from two different studies with different methods and the NOAEL TRV was estimated from an effect-based TRV, no threshold TRV has been calculated for birds. The estimation of the NOAEL TRV from a LOAEL TRV introduces uncertainty in the NOAEL TRV. However, because the LOAEL TRV is based on endpoints appropriate for use by receptors in the WBEU, the uncertainty associated with the TRVs is considered low. The TRVs may overestimate or underestimate risk to an unknown degree.

### *Background Risk Calculations*

PCB was not analyzed for in background surface soils. Therefore, background risks were not calculated for PCB in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

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# COMPREHENSIVE RISK ASSESSMENT

## WIND BLOWN AREA EXPOSURE UNIT

## VOLUME 9: ATTACHMENT 6

## CRA Analytical Data Set